ŠULBA SUTRA

A CRITICAL ANALYSIS

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Doctor of Philosophy

in Sanskrit

By

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Declaration

I do hereby declare that this thesis entitled **"ŚULBA SŪTRA : A CRITICAL ANALYSIS"** is my original work and that it has not previously formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or other similar title

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Certificate

This is to certify that this thesis entitled **"ŚULBA SŪTRA : A CRITICAL ANALYSIS"** submitted by Sri Jayashankara, K to the Mangalore University for the award of the Degree of Doctor of Philosophy in Sanskrit is the result of bonafide research work carried out by him in Canara College, Mangalore under my guidance and supervision

I further certify that this thesis or part thereof has not previously formed the basis for the award of any degree, diploma, fellowship etc of any other University or Institution

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Abbreviations

A Br	*Aıthareya Brāhmana*
Ā Ś S	*Āpastamba Śulbasūtra*
Ā Śr S	*Āpastamba Śrautasūtra*
Av	*Atharvaveda*
B Ś S	*Baudhāyana Śulbasūtra*
B Śr S	*Baudhāyana Śrautasūtra*
Bh Śr S	*Bharadvāja Śrautasūtra*
Ca Pr	*Camaka Praśna*
Chā Up	*Chāndogya Upanısad*
K Ś S	*Kātyāyana Śulbasūtra*
K Śr S	*Kātyāyana Śrautasūtra*
Katha Up	*Katha Upanişad*
Kr Y S	*Kṛsna Yajurveda Samhıtā*
M Ś S	*Mānava Śulbasūtra*
M Śr S	*Mānava Śrautasūtra*
Maı S	*Maıtrāyanīya Samhıtā*
Rv /RV	*Ṛgveda*
Ś Br	*Śatapatha Brāhmana*
Ś P N	*Śrautapadārtha Nırvacanam*
Taı Br	*Taıttırīya Brāhmana*
Taı Saṃ	*Taıttırīya Saṃhıtā*
Vaı Śr S	*Vaıkhānasa Śrautasūtra*
Yv	*Yajurveda*

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Introduction

The **Veda** provides base for *Dharma* Its tradition is a way of life The oral tradition of the Vedic culture were recorded in four Vedas- *Ṛgveda, Yajurveda, Sāmaveda* and *Atharvaveda* But there were several vedic schools, each with its own texts (*samhitas*) and supplementary texts (*Brāhmanas, Āranyakas* and *Upanisads*) The Vedas have six ancillary disciplins named as *Vedangas* or 'limbs of Veda'

The *Vedangas*, an important group of literature constitute an important source in the history of science in ancient India This is evident from such subjects as- phonetics (*śiksa*), ritual (*kalpa*) grammar (*vyākarana*), etymology (*nirukta*), metrics (*chandas*) and astronomy (*jyotisa*)

The *Kalpa* concerned principally with the rituals constituting chief contents of the *Brāhmanas* The *Śrauta* which is one of the branch of *Kalpa* deal with *Śrauta* sacrifices abundantly discussed in the *Brāhmanas* and are naturally concerned with direction for the laying of the sacrificial fires, like '*agnihotra*', the New and Full-moon, the seasonal, the soma and other sacrifices These are important source for the understanding of the Indian sacrificial cult

Śulbasūtras which are the branches of *Śrautasūtras* deal specifically with rules for the measurement and constructions of the various sacrificial fires and altars Consequently these involve mathematics, geometry in particular Thus *Śulbasūtras* constitute an important source of *Veda*, and possibly the earliest, mathematical source in India

The word '*Śulba*' means a 'cord', a 'rope', or a 'string' and its root '*Śulb*' signifies 'measuring' or act of measurement Therefore, the name of the title itself has some special significance '*Śulbavid*' as mentioned in *Mānava Śulbasūtra* (10 1) means, 'one who has taken up measuring as profession' That means, *Śulbavid* is the equivalent word for the geometrician Hence, *Śulba* itself the earliest name of geometry or *Śulbasūtras* may consider as the 'book of geometry'

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But *Śulbasūtras* also involve the constructions of various sacrificial fire-altars and consquently involve, the technology of civil engineering The fire-altars are constructed by burnt bricks with a fixed number of bricks and with a specified area, in different layers involves the ideology of structural planning and a systematic way of construction of brick-building, with perfect measurements

In the First chapter, I explained briefly how the mathematical knowledge and the tradition of sacrifice was developed before the Śulbasūtra period I understood that, the ancient sages did not neglect the material sciences Mathematical knowledge in the vedic period of study are mainly- (1) *Lipi* or *Lekha* (alphabets) (2) *Rūpa* (drawing and geometry) (3) *Ganitha* (mainly arithmatic and algebra) The development of these three subjects were found in the period of *Śulbasūtras*

The Veda was the main source of *Yajña* (or sacrifice) and 'Agni' is described as the 'God of the sacrifices' The concept of *Yajña* has greater significance This is achieved by the performance of sacrifice without any mistake or irregularity This leads to the origin of *Śulbasūtras* Thus the *Śulbasūtras* are the manuals for the performance of sacrifices and these found separately as like *Baudhāyana Śulbasūtra, Āpastamba Śulbasūtra, Kātyāyana Śulbasūtra, Mānava Śulbasūtra* etc

The Second chapter, mainly deals with the definition, meaning and date of Śulba There is an uncertainty regarding the date of *Śulbasūtra* However, *Baudhāyana Śulbasūtra* was the oldest and date of *Baudhāyana Śulbasūtra* believed to be at 800 B C followed by *Mānava Śulbasūtra* 750 B C , *Āpastamba Śulbasūtra* 600 B C , *Kātyāyana Śulbasūtra* which is the latest and belongs to be 300 B C

In the Third chapter, units, instruments found in *Śulbasūtra* and tools of *Yajñ* are discussed *Angula* is considered to be the standard unit, and all other units are derived from this standard unit It is surprising that unit '*hasta*' is popular in the later period, not mentioned in *Śulbasūtras*

In the Fourth chapter, I have analysed the different types of *Vedis* and their measurements The layout of different vedis involves selection of proper ground,

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planning, designing the sketch, measurement etc All these involve a systematic procedures like, construction of building in modern days

In the Fifth chapter, where I analysed the construction of various *citis* It involves geometrical operations of more complex nature The construction of citi follows the placement of bricks in different layers The different sizes of the bricks, its measurement, its placement in a definite order shows civil engineering technology along with perfect calculations The drawings of citis look like architectural designs Eventhough number of bricks, its placement, area of bricks may differ but the total area of the *citi* remains constant (i e $7^1/_2$ sq purusa) This shows the intelligence of the people in *Śulbasūtra* period Thus *Śulbasūtra* may be considered as the part of history of engineering and technology also

In the Sixth chapter, the famous methametical theorem namely, *Pythagorus* theorem analysed in comparison with '*Bhujakoṭi-karna nyāya*' of *Śulbasūtra* There is no doubt that the theorem of Pythagorus was mentioned by *Bodhāyana* and *Āpastamba* in general form Since the date of *Bodhāyana* (800 B C) was known to be older than the date of Pythagorus (540 B C), it must be named as the 'Theorem of Bodhāyana '

In the Seventh chapter, the value $\sqrt{2}$ and π was discussed in detail The value of $\sqrt{2}$ was perfect upto four decimals ($\sqrt{2}$=1 4142157) This shows the degree of accuracy gained by *Śulbasūtrakāras* in methametics The value of π according to *Bodhāyana* was 3 008 which is also very close to the modern value of 3 14

In the Eighth, the last chapter, I compiled almost all methametical theorems which were directly and indirectly found in *Śulbasūtras* The transformation of geometrical areas are considered to be higher analytical geometry in modern mathematics

Thus, the *Śulbasūtras* have an important place in the history of Indian Scientific Thought and development The learned scholars should not neglect the actual thoughts found in *Śulbasūtras* and I feel that still these rules have their relevence in the modern world

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Chapter - 1

Vedas and Vedaṅgas : Place of Šulba

Introduction :

'Veda is the source of '*dharma*' and the tradition and practice of those persons who know the Veda '[1] The word '**Veda** is derived variously from the roots '*vid*' and '*vidlr*' means 'to know' (*vijñāne*) and to obtain ('*vidlr lābhe, vinda prāptau*) [2] Thus Veda is considered as the treasure-house of knowledge The Veda is tradition and way of life **Yājñavalkya** declares that 'Veda, traditional lore, usages of good men, what is agreeable to one's self and desire born of deliberation, this is traditionally recognised as the source of '*Dharma* '[3] Thus the deep study of Veda makes to understand the nature and the evolution of the thought process

The core of this Vedic tradition were recorded in four Vedas, namely, '*Ṛgveda*, '*Yajurveda*', '*Sāmaveda*' and '*Atharvaveda* ' But there were several Vedic schools, each with its own texts (the '*saṃhitas*') and supplementary texts ('*Brāhmanas*', '*Āranyakas*', and '*Upanisads*') [4]

This Vedic tradition recognises that, physical sciences are not the only means of knowledge, but also inner spiritual sciences The physical development should not make us blind to the realities of the mind and spirit The aim of Vedic sages was realization of inner spiritual life Therefore, it is said that in ancient India no science did ever attain an independent existence and was cultivated for its own sake Whatever of any science is found in Vedic tradition is supposed to have originated and grown consequently with the primary object of helping of the Vedic rituals 'Thus Vedas

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1 वेदोऽखिलो धर्ममूल स्मृतिशीले च तद्विदाम्। म स्मृ II-6

2 शब्दकल्पद्रुम, Vol iv, P 467

3 श्रुतिः-स्मृतिः-सदाचारः स्वस्य च प्रियमात्मनः।
सम्यक् सङ्कल्पजः कामो धर्ममूलमिद स्मृतम्।। याज्ञ I-7

4 Table -1 (Classification of Vedic schools) in Appendix I

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considered as only spiritual books having some recital hymns But there are several evidences to prove that Vedas are not only filled with deep penetrating spiritual knowledge but equally piercing and systematic knowledge of the material world, in a most sceintific way

For example,

In the *Chhāndogya Upanishad*, when **Nārada** approached **Sanatkumāra** to teach him, Sanatkumara asked him to inform whatever he has already studied Answering this question Nārada gives a long list of the subjects already studied These include-

'*Itihāsa, Purāna, Rāśi* (i e Mathematics), '*Nidhi*' (i e Mineralogy), '*Vākovākya*' (i e Logic), '*Ksatravidyā*', (i e Political science and warfare), '*Naksatravidya*', (i e Astronomy), '*Bhūtavidya*,' (i e Physical sciences), '*Sarpavidya*,' (i e the lore dealing with the snake - serpent-lore) and so on [राशिम् निधिम् वाको - वाक्यम्, क्षत्रविद्या नक्षत्रविद्याम् - एतद् भगवोऽध्येमि . । (vii, 1, 2, 4)] From this it is clear that a large number of modern science subjects covered as early as the 'Chhāndogya Upanishad' (i e 900 B C -500 B C) Hence ancient Indian sages did not neglect the physical sciences

Mathematical knowledge in Veda Period :

Mathematics represents a high level of abstraction attained by the human mind In India, mathematics has its roots in Vedic literature which is nearly 4000 years old [5] The Brāhmana literature (c 2000 B C) which follows the Vedas, advances in Mathematics like in Geometry and Algebra The mathematical genius of the ancient Indians was mainly computational and leads to spectacular achievements in geometry Thus their main subjects of study are (1) '*Lipi*' or '*Lekha*' (alphabets), (2) '*Rūpa*' (drawing and geometry), (3) '*Ganita*' (arithmetic) Eventhough, religion being prime avocation of the earlier Indians, we have to show that in course of time the physical science like Mathematics out grew their original purposes and they were cultivated in adjunct to '*parā vidya*' (or spiritual knowledge)

There are a number of evidences to show that the knowledge of geometry is

5 R C Majumdar, Proceedings of National Institute of Science of India (NISI), 18, P 331

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originated from the Vedic period itself The chariot of '**Aśvinīkumāra**' was triangular having three seats and three wheels [6] Two type of wheels for chariots are mentioned A wheel formed of hub, spokes felly rim another is the solid one The chasis of wheels generally have five spokes with felly [7] The metallic rim was provided around felly [8] The solid wheel, have three main parts- central hub ('*nābhi*') upādhi and '*pradhī* [9] The '*nābhi*', felly and the central hole must be concentric The Rgvedic people may, therefore, be knowing the construction of drawing concentric circles of desired diameters The names of chariot makers that occur in the Ṛgveda are **Bhṛgu, Ṛbhus, Tvaṣṭṛ** and others [10] Wells were covered by the owners [11] Depending upon the shape of the well, knowledge of geometry is required for preparing the cover to the mouth of a well

By the time of *Yajurveda*, the number and variety of chariot that were manufactured and were increased to such an extent that a separate guild of chariot-makers ('*Rathakāras*') was developed [12] In the Atharvaveda the layout of the house on the ground was also mentioned [13] The builders of the house used to be different from the owners [14]

A few geometrical terms also found in the three Vedas i e *Ṛg*, *Yajus* and *Atharva*, are as follows

The first 'mantra' of '*Purusasūkta*' is-

---

6 त्रयः पवयोः रथे। (Ṛv I, 34 2), त्रिबन्धुरेण त्रिवृता रथेन त्रिचक्रेण सुवृता। Rv I-118 2)

7 पञ्चारे चक्रे । (Ṛv II, 18 4)

8 अरान्न नेमिः परि ता बभूव। Rv 1 32 15 also 1 141 9

9 पवयः (Ṛv. 1 139 3) रुक्मो न चित्रः स्वाधितीवान् पव्या रथस्य जङ्घनन्त भूम। Rv 1 88 2

10 एवेदिन्द्राय वृषभाय वृष्णे ब्रह्माकर्म भृगवो न रथम्। (Rv IV-16 20) एत वा स्तोममश्विनावकर्मातक्षाम भृगवो न रथम्। (Rv X 39 14)

11 आवतासोऽवतासो न कर्तृभिस्ततूषु ते ऋतव इन्द्र भूरयः। (Ṛv I-55 8)

12 नमस्तक्षभ्यो रथकारेभ्यश्च वो नमो नमः। Yv 1627

13 पृथिव्या निमिता मिता। Av IX 3 16, 17

14 यस्त्वा शाले प्रतिगृह्णाति येन चासि मिता त्वम्। Av IX-3 9

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सहस्रशीर्षा पुरुषः सहस्राक्षः सहस्रपात् ।
सभूमि विश्वतो वृत्वाऽत्यतिष्ठद्दशाङ्गुलम् ॥ Rv X 90 1

'*Sahasra*' (सहस्र) itself denotes thousand while '*atyatistha*' is a mathematical term indicating 'remained over' or remainder after subtraction The word '*angulam*' mentioned may have the meaning as the unit of length measure '*angulam*', rather than fingers

In the tenth '*mandala*' of the Rgveda,[15] the word '*pramā*' means measure, '*paridhiḥ*' means circumference and '*Pranga*' means triangle The idea of dividing a circle into 360° may have been developed from the *Ṛg vedic* period One of the *Rk*[16] conveys that 'The follies are twelve, the wheel is one, there are three hubs but who knows it? Within it are collected three hundred and sixty spokes, which are as it were, moveable and immoveable

All the above examples show that, the mathematical aspects are as early as Ṛgveda itself There are many arithmetic terms were found in the Ṛgveda, the Yajurveda and the Atharvaveda The figures and values were fixed at the time of the Rgveda So the figures may be listed with their increasing order as below

One year (I-110.4) एक संवत्सरम्

Ninety four (I-155.6) चतुर्भिः साकं नवतिम्

Ninety nine (I-54.6, I-84.13) नवभिः साकं नवतिम्

3309 gods (III-9.9) त्रीणि शता त्री सहस्राणि त्रिंश्च्य देवाः

30,000 (IV-30.21) सहस्रा त्रिंशत्

One lakhs (II-14.6) शतं सहस्रम्

Many lakhs (II-14.7) शतमा सहस्रम्

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15 काऽसीत् प्रमा प्रतिमा किं निदानम् आज्य किमासीत् परिधिः क आसीत् ।
छन्दः किमासीत् प्रङ्ग किमुक्थ यदेवा देवमयजन्त विश्वे । Ṛg X 130 3

16 द्वादश प्रधयश्चक्रमेक त्रीणि नभ्यानि क उ तच्चिकेत तस्मिन्त्साक त्रिशता न शङ्कवोऽर्पिताः षष्ठिर्न चलाचलासः ।
Rg I-164 48

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In *Purusasūkta* (Rv I-90 3) the subtraction of quarter from one is given as three quarters Mathematically it is correct [$1-\frac{1}{4} = \frac{4-1}{4} = \frac{3}{4}$][17] The '*Maitrāyanī Samhitā* (3 7 7)[18] mentions about several fractions $^1/_{16}$ is '*kala, kusth*' = $^1/_{12}$, '*śapha*' = $^1/_8$ and *pāda*' = $^1/_4$ These names of fractions referred in context with bargaining for a price of material (here it is '*Soma*') to be purchased The price of the material is increased step by step Therefore they are naming the fractional numbers in an order This shows that, the operations like sum, subtraction of fraction would be quite common and of every day use at that time

In the Yajurveda the series of odd and even figures are mentioned The odd figures are- 1, 3, 5 . 31, 33[19] Similarly even numbers are- 4, 8, 12 upto 48 [20] The series of fraction is given as $^1/_2$, $1^1/_2$, 2, $2^1/_2$, 3, $3^1/_2$ and 4 [21] In '*Śatapatha Brāhmana*' the fundamental[22] mathematical operation is found The division of thousand by three gives 333x3+1 The problem of dividing thousand by three is in a poetic way The '*Taittirīya Samhitā*' says only gods, Indra and Visnu could succeed in solving this But solution is given in '*Śatapatha Brāhmana*' as mentioned above In the Atharva Veda very large figures like '*sahasra*', '*ayuta*', '*nyarbuda*' 'are used as if they were very common Actually these large figures are used in praising the god Indra But the numbers taken into consideration with prescribed manner as

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17 पादोऽस्य विश्वा भूतानि त्रिपादस्यामृतं दिवि । (Rv I-90 3)

18 वसोर्ह्येष विन्दते यः सोम क्रीणाति । सोमविक्रयिन् सोम ते क्रीणानि महान्त बह्वह बहु शोभमान कलया ते क्रीणानि कुष्ट्या ते क्रीणानि कुष्ट्या ते क्रीणानि शफेन ते क्रीणानि पदा ते क्रीणानि ।। (3 7 7)

19 एका च मे तिस्रश्च मे पञ्च च मे सप्त च मे एकवितंशति च मे त्रयोवितंशतिश्च मे पञ्चवितंशतिश्च मे सप्तवितंशतिश्च मे नववितंशतिश्च मे एकत्रितंशच्च मे त्रयस्त्रितंशच्च मे । (18 24)

20 चतस्रश्च मेऽष्टौ च मे द्वादश च मे षोडश च मे वितंशतिश्च मे अष्टाचत्वारितंशच्च मे । (Yv 18 25)

21 त्र्यविश्च मे त्र्यवी च मे दित्यवाट् च मे दित्यौही च मे पञ्चाविश्च मे पञ्चावी च मे त्रिवत्सश्च मे त्रिवत्सा च मे तुर्यवाट् च मे तुर्यौही च मे यज्ञेन कल्पताम् । (Yv 18 26)

22 तद्यत्रैतात्त्रिरात्रे सहस्र ददाति । तदेषा साहस्री क्रियते स प्रथमेऽहस्त्रीणि च शतानि नयति त्रयस्त्रितंशत चैवमेव द्वितीयेऽहस्त्रीणि चैव शतानि नयति त्रयस्त्रितंशत चैवमेव तृतीयेऽहस्त्रीणि चैव शतानि नयति त्रयस्त्रितंशत चाथैषा साहस्यतिरिच्यते । Ś Br IV-5 8 1

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'*sahasra* - 10^3, $10x10^3$ -which is '*ayuta*' (10^4) and 10^5 is '*nyarbuda*'[23] It also appears that decimal system was in vogue at the time of the Atharva Veda [24]

From the above evidences it could be stated that Vedas contain the methametical sciences like arithmetics and number system These arithmetic and algebric numbers originated in connection with the construction of the altars for the Vedic sacrifices The expression '*yajña*' has a great antiquity and we find it employed even in the early hymns of the Rgvedic collection In *Purusasūkta* of the Rgveda we read that the gods who were first created performed a sacrifice [25] The sacrifice was for them an instrument as well as their objective and out of this pre-mordial sacrifice, the first principles of life were formed [26] The word '*yajña*' has a wider range and more purposeful than a sacrificial rite Among other synonymous expressions which emphasise the aspect of offering are '*sava*', '*makha*', '*isti*', '*savana*', '*homa*', '*āharea*' and '*havana*' [27] The word '*adhvara*' means a sacrifice, where violence is avoided ('*a-dhvara himsa karma*')

Vedic Sacrifice and its importance :

The Vedic sacrifices are mainly of three classes- '*Nitya*' (or indispensable) *Naimittika* (or intentional) and '*Kāmya*' (optional) The performance of the '*nitya*' sacrifices and *naimittika* are obligatory upon every Vedic Hindu But it is not so with the sacrifices of the third kind For, they are to be performed each with the sole

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23 बृहत् ते जाल बृहदिन्द्र शूर सहस्रार्धस्य शतवीर्यस्य ।
तेन शतं सहस्रमयुत न्यर्बुद जघान शक्रो दस्यूनामभिधाय सेनया ।। (Av VIII-8 7 }

24 पञ्च च याः पञ्चशश्च सयन्ति मव्या अभि ।
इतस्ताः सर्वा नश्यन्तु वाका अपचितामिव ।।
सप्त च याः सप्ततिश्च सयन्ति ग्रैव्या अभि ।
इतस्ताः सर्वा नश्यन्तु वाका अपचितामिव ।। (VI-25 162)

25 यत् पुरुषेण हविषा देवा यज्ञमतन्वत । Rg X-90 16)

26 यज्ञेन यज्ञमयजन्त देवाः तानि धर्माणि प्रथमान्यासन् । (X-90 20)

27 यज्ञस्सवोऽध्वरो यागसप्ततन्तुर्मुखः क्रतुः
पाठो होमश्च । A K P 103 Sl 418

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motive of achieving a special object Those who do not aim at the attainment of any such object need not perform any of them The relevance of sacrifice is based on the assumption of his being the leader of all the gods and the fore-runner[28] and the first divinity to arrive in sacrifices The very first '*mantra*' in the Rgveda is in adoration of *Agni*[29] who is described as god of the sacrifice Agni is all-pervading and ever present, he has three forms according to the Rgveda[30] as '*baḍabānala*' (बडबानल) in the ocean, as '*āditya*' in the heavenly firmament and as '*vaidyutagni*' (the thunder-bolt) in the mid region He was brought from the high heavens to the earth and he is hidden in the earth, he is the controller of all things and indeed he becomes the visible god when the sacred fire ('*yājakāgni*') is set up on the sacrificial platform, i e '*Vedi* '[31] The Atharva Veda speaks of '*yajña*' as the chariot of the gods (देवरथ) The four directions are the mules yoked to it, the '*purodāśa*' offerings are the hooves of the mules, the mid region is the body of the chariot, the sky and the earth are the side wings, the seasons are the reins that regulates the mules, voice is the hood of the chariot and the inter-spaces are the grooms that go with the chariot (8 9 22) [32] There is interesting narration in the Rgveda where *Agni* is compared to the rim of the wheel ('*nemi*') which surrounds the wheel, *Agni* pervades all the acts performed by the peniests, even as the rim pervades the wheel [33] Therefore *Agni* is identified with *yajna* If the *yajna* is referred to as the birth place of *Agni*,[34] the *yajna* is also described as Agni himself [35] The Krsna Yajurveda Saṃhita gives a detailed account

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28 अग्निर्वै देवाना मुखम् । अग्रनीर भवति । Nirukta, 7, 14, 4

29 अग्निमीळे पुरोहितम् । यज्ञस्य देवम् । Rv I-1 1 1

30 त्रीणि जाना परिभूषति अस्य । Rv 1 95 3

31 समिद्धो अग्निर्निहितः पृथिव्या प्रत्यङ्विश्वानि भुवनान्य स्यात् ।
होता पावकः प्रदिव सुमेधा देवो देवान् यजत्वाकीरर्हन् ।। Rv 203 1

32 दशश्वतस्रोऽश्वतर्यो देवरथस्य पुरोडाशाः शफ़ा अन्तरिक्षमुद्धिः ।
द्यावापृथिवी पक्षसी ऋतवोऽभीशवोऽन्तर्देशाः किङ्करा वाक् परिरथ्यम् ।। Av 8 9 22

33 दधन्वे वा यदिमनु वोचद् ब्रह्माणि वेरु तत् परि विश्वानि काव्या नेमिश्चक्रमिवाभवत् ।। Rv 2 5 3

34 योनिं अग्नये । Rv I-140 1

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of the various benefits that result from the performance of a sacrifice Among such benefits are abundance of food (बाज)[36] wealth (प्रसव) efficiency in work, mental application (धिति) light of knowledge (ज्योति), bodily vigour (ओजस्) longevity (दीर्घायुः) health (अनामय), happiness (शर्म) fearlessness (अभय) friendliness (अनमित्रम्) and sound sleep (सुखं शयनम्) The sacrificer prays that this life may become worth while by the sacrifice that he performs The symbolism of sacrifice is really self-sacrifice-giving oneself up, but for purposes of more effective regeneration We have in the same text another account explaining the significance of *yajña*, they i e priests kill during the sequence of crushing (अभिषवन) and create again during the subsequent sequence While it is being destroyed, it is born again, and this is *yajña*[37]

The three types of Agnis :

In the sacrifice it is said that the Agni kindles the *Agni*,[38] which is symbolically enacted in kindling the '*āhavanīya*' fire from the '*gārhapatya*' fire in accordance with Rgveda There is mention in that work of three places of the *Agni*[39] Though we do not find there any specific mention about the relative size and shapes of these altars these three places of the *Agni* imply the '*Gārhapatya, Āhavanīya*' and '*Dāksinātya*' It has been shown by Oldenberg that those three fires are earlier than the Rgveda[40] According to Subodh Kapoor[41] the "three places" of *Agni* doubtlessly imply the '*Gārhapatya, Āhavanīya*' and '*Dāksinātya*', because the mention of '*Gārhapatya*' a fire by name in the Ṛgveda itself[42] But it should be made clear, there is no particular

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35 योनिर्यद् अग्नियंज्ञेः । ऐ ब्रा 1 16

36 अग्राविष्णू सजोषसेमा वर्धन्तु वा गिरः । द्युम्नैर्वाजेभिरागतम् ।। वाजश्च मे प्रसवश्च मे प्रयतिश्च मे प्रसितिश्च मे धीतिश्च मे क्रतुश्च मे स्वरश्च मे श्लोकश्च मे श्रावश्च मे श्रुतिश्च मे ज्योतिश्च मे सुवश्च मे प्राणश्च मेऽपानश्च मे ओजश्च सहश्च मे आयुश्च मे शर्म च मे वर्म च मेऽङ्गानि च मे आयुर्यज्ञेन कल्पता प्राणो । च प्र 9 21

37 यज्ञेन यज्ञमयजन्त देवाः तानि धर्माणि प्रथमान्यासन् । (X-90 20)

38 अग्निनाग्निः समिध्यते । Rv I-12, 6

39 यज्ञस्य केतु प्रथम पुरोहितमग्निं नरस्त्रिषधस्थे समीधिते । Ṛv V-11 2

40 Oldenberg Religion Des Veda, S B E Vol XXX No 2 P 348

41 Ancient Indian Sciences, Vol 1, Ch 9, P 111

42 गार्हपत्येन सत्य ऋतुना यज्ञनीरसि । देवान् देवयते यज । I-15 12

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rule for the construction of the altars in the Ṛgveda We cannot indeed reasonably expect to find such a rule there, when we remember the nature of that work However, there were then learned experts to do the construction of fire-altars An expert in that science is called '*Agnicit*' (or the constructor of the '*Agni*' or Fire Altar)[43]

We next turn to the Yajurveda which has very rightly described the '*tretāgni*'s The '*gārhapatya*' fire means household fire which is regarded as the foremost (पुरोवर्ती) representing human being on earth The '*āhavanīya*' fire is symbolic of sun in the cellestial region where gods abide [44] The '*daksināgni*' is symbolic of the manes (पितृ) and evil spirits who dwell in the mid region This represents the wind-god (वायु) [45] Thus the three fines which are employed in the ritual known as '*agni-hotra*', represents *Agni* (on the earth, '*prthvi*'), '*Sūrya*' (the agni in the mid region- '*antariksa*') or moon (as the light of the manes) declares that the three fires are the three worlds [46] If a person who maintains the three fires is called '*Vaitānika, Pañcāgni*' is the person who tends two additional fires '*Sabhya*'' to be placed in an assembly or '*sabhā*' and '*āvasathya*' to be placed in a rest house The fire for sacrificial purpose is always produced by rubbing or churning the dry firewood (अरणि) from trees like '*śami*' and '*aśvattha* '[47]

Types of Sacrifices :

The '*yajña*' is of many kinds, depending upon several details like the purpose for which it is done Usually sacrifices are classified into two groups- (i) '*śrauta yajñas*' and '*grhya yajñas*' (also called '*Pākayajñas*') The latter are much simpler than the former, and involve boiled '*caru*' as oblations offered to the house-hold fire ('*grhyāgni*') The main varieties of '*Grhya Yajñas*' are- (i) '*Aupāsana*' (औपासन) '*homa*', (ii) '*Vaiśvadeva pārvana*' (iii) '*Aṣṭaka*' (iv) '*Māsi-śrāddha*' (v) '*Sarpa-bali*'

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43 तैत्तिरीय सहिता V-7 6 1

44 एतद् वै देवाना आहवनीय यद् आहवनीयम् । Tai Sam, I-6 7 1

45 यदा वै पुरुषोऽस्मै लोकान् प्रैति स वायु आगच्छति । S Br 14 8, 12 1

46 इमे वा एते लोक अग्नायाः । Tai Sam 1 1 8

47 शमीगर्भादग्नि मन्यति । एष वा अग्नेर्याज्ञीया तनुः । Tai Bra 1,1,9,1)

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(vi) '*Īśāna-bali* (ईशान) [48] The '*śrauta yajñas*' are of two major kinds- '*havir-yajñas*' and '*soma-yajñas* ' The oblations in '*havir-yajñas*' are clarified butter -ghee- ('ājya') boiled preparations of rice, barley or wheat ('*caru*'), the faggots of selected trees ('*samidhā*') etc , whereas oblation in the '*soma-yajñas*' is the soma-juice, which is also drunk later by the '*yajamāna*' and '*Ṛtviks*'[49]

Each of these two kinds has seven varieties (known as '*saptasaṃhitā*') The seven '*havir-yajñas*' are also called '*iṣṭis*' (इष्टि), they are '*agnyādheya, agni-hotra, daiśa-pūrnamāsa, āgrayana, cāturmāsya, dāksāyana*' and '*sautrāmani* [50] But 'Gautama Dharmasūtra'[51] have lists as follows '*Agnyādheya*', '*agnihotra*', '*paurnamāsī*', '*amāvāsya*', '*cāturmāsya*', '*nirūḍha-paśu-bandha*' and '*navesti*' But Gopatha Brahmana has different list '*agnyādheya*', '*agnihotra*', '*paurnamāsi*', '*amāvāsyā*', '*cāturmāsya*', '*nirūdha-paśu-bandha*' and '*navesṭi*', according to the latter text, while the former text substitutes '*dāksāyana*' with '*nirūdha-paśu-bandha*' [52]

The soma-yajñas are- *agnistoma, atyagnisṭoma, ukthya, sodaśin, vājapeya,* atirātra and āptoryāma Some sacrifices are allowed only for the ruling princes like '*aśva-medha*' (performed by an emperor to get rid of his sins and achieve sovereinghty), '*rāja-sūya*' (performed by the ruler to assert his superiority in the realm), '*sarva-medha*' (performed by one who is the sole monarch), '*purusa medha*' (involving human sacrifice) '*aindra-mahābhiseka*' (for obtaining special energy and extraordinary qualities) and '*vājapeya*' (which is meant to confer upon the performer superior strength and divinity)[53] The *soma-yajñas* are prescribed by all the three

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48 Āpastambha - Paribhāṣasūtra 1 4 6

49 Gauthama Darmasutra, 1 8 10

50 Sayana Commentary on Aitareya Brāhmana, 5 7

51 Gautama Dharma sutra, 1 8 20

52 Gopatha Brahmana, 1 523

53 Śukla Yajurveda Saṃhita, chapters- 4 to 8 and chapter 9 & 10 These chapters explains these concepts in detail

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Vedas (Rg, Yajus and Sāma) whereas some sacrifices like *darśa-pūrnamāsa* by two Vedas only (Rg and Yajus)

All sacrifices have three aspects (i) '*uddeśa*' (intention), viz the God for whom the sacrifice is meant, (ī) '*Tyāga*' (what is given up), viz the offerings or the '*havis*', and (ii) '*praksepa*' (thé prescribed spot or particular fire where the offering are delivered

Vedāṅgas - Its importance :

The *Vedangas*, (or limbs of the Veda) that important group of literature often referred to as the appendages or limbs of the Vedas, constitute an important source in the history of science in ancient India These branches of study arose within the Vedic schools themselves as a necessary condition for mastering the Vedas [54] This six limbs of Veda are- 'śiksā' (phonetics), '*vyākarana*' (grammar), '*chandas*' (metrics), '*nirukta*' (etymology), '*jyotisa*' (astronomy) and '*kalp*a' (ritual) [55] This class of literature was written in a form of expression characterised by great precision, brevity and economy of words, the like of which may not be met with in the entire literature of the world [56] The style has been developed to sum up only the pith of the learning in short sentences using nouns often compounded at great length and avoiding the use of verbs as far as possible This style, most commonly known as sūtra style became a dominant feature of the various branches of *Vedangas* Therefore the age of the *Vedāngas* was considered assūtra period (i e 800 B C -200 B C)[57]

Kalpasūtras :

As I said already, Kalpa is one of the branch of Vedangas Since this work is composed in the form of *sūtras* (aphorisms) it is also named as '*kalpasutras*' These were concerned principally with the rituals constituting the chief contents of

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54 अङ्ग्यन्ते ज्ञायन्ते अमाभिः इति अङ्गानि - वेदस्य अङ्गानि वेदाङ्गानि । स व्या स P 63

55 शिक्षा व्याकरण छन्दः निरुक्त ज्योतिष तथा ।
कल्पश्चेति षडङ्गानि वेदस्याहुर्मनीषिणः ।। वेदाङ्गज्योतिषम् ।

56 अल्पाक्षरमसन्दिग्ध सारवद्विश्वतो मुखम् ।
अस्तोभमनवद्य च सूत्र सूत्रविदो विदुः ।। लघुसिद्धान्तकौमुदी, P 4

57 R C Gupta Students Britannica, Vol 6, Pp 321-334

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Brāhmanas, are supposed to be the first *Vedānga* to have received systematic treatment [58] It is said that "the scripts in which rites and rituals regarding *Yāgas* and *Yajñas* are described are called *Kalpasūtras* [59] Thus kalpa has paramount importance in understanding the Vedic rituals

Kalpasūtra deals with the rules and methods for performing vedic rituals, sacrifices and ceremonies In *Krsna-yajurveda saṃhita* (ch 18 9 21) there is a word '*Kalpantām*' which is used in the sense of 'benefits' A detailed account of the various benefits that result from the performance of a sacrifice [60] The sacrificer prays that his life may become worth while by the sacrifice that he performs

A distinction is drawn between Kalpa and Kalpasūtra by Tantravārttika [61] The word *Kalpa* (or rather *Kalpasūtra*) is used in two senses, one comprehensive including the aphoristic works on Vedic ritual, on the domestic ceremonies and also on law, government and administration of justice, the other sense covers only those aphoristic works that deal with Vedic sacrifices and matters related therto If the first sense is taken then *Kalpasūtras* are classified into three classes,[62] viz (1) *Śrautasūtras* that deal with solemn Vedic sacrifice, mentioned or discussed in the Vedas and Brahmans (2) *Grhyasūtras* that deal with domestic ceremonies such as '*Upanayana*', marriage and with daily and periodical rites and employ mantras for them mostly from one '*śākha*' of the Veda (3) *Darmasūtra* that treat of some of the topics dealt with in the *Grhyasūtras* but add provisions on matters concerning economic life, politics government, civil and criminal law A complete kalpa in the first sense should cover all the three divisions It is highly doubtful whether each Veda śākhā had originally a complete set of three kinds of works covered under the *Kalpa* [63] There is no

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58 Winternitz, I pt 1, 237, also see Sen, Chapter on 'A survey of source materials', A Concise History of Science in India

59 कल्पन्ते समर्थ्यन्ते यज्ञयागादि प्रयोगाः इति कल्पः । Kalpasūtra, P 8

60 प्राणो यज्ञेन कल्पताम् । वाक् यज्ञेन कल्पताम् । आत्मा यज्ञेन कल्पताम् यज्ञो यज्ञेन कल्पताम् ।।

61 On Pūrva Mīmāṃsasūtras, I-3 11

62 Sometimes Śulba is taken as fourth class Winternitz- A Concise History of Sciences in India, P 26

63 'India of Vedic Kalpasūtras', P 82-84 (Doctoral thesis by Dr Ram Gopal, 1959

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dharmasūtra completing the *Āśvalāyana śrauta* and *Grhyasūtras*, no *Mānavadharma sūtra* has yet come to light, though the *Mānavaśrauta* and *Grhyasūtras* are found In the same way we have *sānkhyāyana śrauta* and *Grhyasūtras* but not *sānkhyāyana dharmasūtra* It is only in the case of *Baudhāyana, Āpastamba & Hiranyakeśin sūtrācaranas* that we have a complete *kalpa* tradition with its three components of *śrauta, grhya and dharmasūtras*

Before proceeding further about *śrautasūktas* a few preliminary remarks must be made Ancient Sanskrit writers and modern historians of Sanskrit literature divide ancient Sanskrit works into three groups viz , the *Vedic Samhitas* (Rgveda, Yajurveda, Sāmaveda and Atharvaveda), the *Brāhmanas* (including the early upanishads like the *Brhadāranyaka*) and the *sūtras* The first two groups together constitute Veda or *śruti*[64] *Sūtras* are not Vedas, but many of them are connected with the Vedas and contain numerous mantras But still the sūtras (*śrauta, grhya & dharma*) are found to be in later class

Today 13 *śrautasūtras* are available[65] They are Sānkhyāyana and Āśvalāyana śrautasūtras of Rgveda Saṃhita, Kātyāyana Śrautasūtra of Śukla Yajurveda Samhita, Baudhāyana, Āpastamba, Hiranyakeśi, Bhāradvāja, Mānava and Vaikhānasa attached to Krsna Yajurveda Saṃhita, Masaka, Lāṭyāyana and Dāksāyana attached to Sāmaveda Samhita, and Vaitāna Śrautasūtra of Atharveda Samhita The Śulbasūtras have been developed as an adjunct to different Śrautasūtras (See Table - 1 in Appendix I) For example, Dr Caland in his monograph (1903) '*Uber das Rituelle śūtra des Bodhāyana*' gives on p 12 the contents of the Bodhāyanasūtra (totally) as follows

Praśnas I-XXI *Śrauta*, XXII-XXV *Dvaidha* XXVI-XXVIII *Karmāntra* XXIX-XXXI *Prāyaścitta* XXXII **Śulbasūtra** XXXIII-XXXV *Grhyasūtra* XXXVI *Grhya prāyaścitta* XXXVII *Grhyaparibhāsa* XXXVIII-XLZ *Grhyaparisista* XLII-XLIV *Pitrmedha* XLV *Pravara* XLVI-XLIX *Dharma*[66]

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64 मन्त्राश्च ब्राह्मण च वेदाः । Pūrva Mīmāmsasūtra, II-1 33

65 Āpastamba śrautasūtra - introduction

66 Dr Calanel edited ninepraśnas of śrautasūtra for the Bibliotheca Indica series, Calcutta (1904)

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So if we consider the contents of the 'Baudhāyanasūtra', the 32nd section or *praśna* the *Śulbasūtra* Similarly if we consider the contents of 'Āpastambasūtra' 30th praśna is *śulbasūtra*, the first 24 *praśnas* contain the treatment of śrauta sacrifices [67] By seeing this, one would accept as many number of śrautasūtras equal to saṃhitas, but that is not the case Similarly, Śulbasūtras available today are much lesser than the number of *Śrautasūtras* and *Samhitas* No śulbasūtra attached to Ṛgveda and Atharva Veda *Samhita* is available today [68] Only one Śulbasūtra namely, *Maśaka* attached to *Sāmaveda Saṃhita* is being referred to [69] One Kātyāyana Śulbasūtra attached to Śrautasūtra of same name of Śukla Yajurveda Samhita is found mentioned Four Śulbasūtra namely, *Baudhāyana, Āpastamba, Vādhūla* and *Hiranyakeśi* of Taittirīya Samhita, two Śulbasūtra of Kāthaka Kāpiśthala Saṃhita all three Samhitas attached to Krsna Yajurveda are found mentioned (See Table - 1 in Appendix I)

Out of these nine Śulbasūtras scholars consider four very important They are (1) Bodhāyanaśulbasūtra (2) Āpastambaśulbasūtra (3) Kātyāyanaśulbasūtra (4) Mānava sulbasūtra These śulbasūtras are available in printed form[70] and other are known through references [71]

Conclusion :

Thus these Śulbasūtras which form one of the section of the Kalpa of Vedānga constitute an important source in the history of science in ancient India and also constitute an important source in the construction of various sacrificial altars and fires of Vedic rituals or ceremonials

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67 History of Dharmasūtra, P 53

68 A Concise History of Science in India, P 1-2

69 Bharatiya Dharma vs Tatvajñāna- Wasneka S B , Ch 3-4, SSPS, P 605-8

70 SEN and Bag- The Śulbasūtras of BŚS, ĀŚS, KŚS, MŚS

71 Manuscript of above four Śulbasūtras available in Mysore Oriental Library Others are found while explaining the Śrautasūtras

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Chapter - 2

Definition, Meaning and Date of Śulba

Śulbasūtras deal specifically with rules for the measurements and construction of various sacrificial fires and altars The very purpose of the Śulbasūtras is to meet constructional requirements[1] for performing different sacrificial rituals [2] Therefore, it is obvious that the Śulbasūtras had given only the necessary formulae and statements of theorems as a material for the accurate layout and construction of altars but not the derivations or proofs of them directly

In spite of that the proofs and derivations might have been arived by them for the theorems, formulae etc Because for the accurate construction of the various fire altars previous knowledge of geometry to the highest degree was essential Hence the title **'Śulbsātra'** has special significance

Meaning of Śulba:

The title 'Śulbasūtra' itself a creative name In Sanskrit, the words '*Varātaka rajju'*, *'śulba'* and *'sūtra' 'vati'* have identical meanings [3]

The two words of identical meaning united in the title name "Śulbasūtra" Thus it should be critically analysed first The word 'Śulba' is derived from the Sanskrit root Śulb (शुल्ब्) meaning 'to measure' [4] and it is a '*ubhayapada*' (i e both '*Parasmai-padi*' and '*Ātmanepadi*') (शुल्ब- ल्ब-यति-ते). It has other meaning as 'to give, bestow,

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1 Especially the layout for the different sacrifices

2 इष्टिकसौमिकपशुबन्धिक दार्वीहोमिकाः समविषमधनुर्मण्डल चतुरश्रत्र्यश्रनानाश्रयो गार्हपत्यायतनप्रभृतिचित्येष्टका पर्यन्तानियतपरिमाणदेशविशेषास्तत्रतत्रोक्ताः तेऽपि मानव्या इति तद्विमान प्रति साधनाभूत शुल्ब विषय प्रतिपादनम् ॥ – आ शु सू करविन्दीया भाष्य

3 शुल्ब (न) बराटक (पु) रज्जु (स्त्री) वटी (स्त्रीलिङ्ग) अमरकोशः, P 216
सूत्र-सूत्रयति -ते सूत्रित- Sanskrit English Dictionary - V S Apte, P 610

4 शुल्ब- क माने+छञ् । शुल्ब्-धातुः शल्बयत्यनेनेति शल्ब (प प +आ प -शुल्बयति -शुल्बते) शुल्बयति वेद्याः पृथिवी परिमाति सृजति वा इत्यर्थः । -शब्दकल्पद्रुमः, P २२४

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or to send away or dismiss' शुल्बं (ल्बं), (i e Neuter) means a rope, sting or a sacrificial rite or act [5] It also means 'a rule, law, or an institute and hence its etymological significance is measuring or act of measurement' According to Nageshwara Shastri, Śulba is in terms of 'preparation' It is preparation for the sacrificial fire [6] In Sanskrit the words śulba and *rajju* have the identical significance which is ordinarily 'a rope', 'a cord' or 'a string' But these two words have special consideration In Katyāyana Śulbasūtra[7] some Sanskrit words are mentioned which looks like mathematical words '*Sānkhyajña*' means one who was well versed in numbers, '*parimānajña*' is he who is expert in measuring '*Sama-sūtra nirañchaka*' means uniform rope-stretcher, the Śulba is "*Śulbapariprcchaka*" In Mānava śulba a word '*Śulba-vid*'[8] is defined In Śulbasūtras we indeed find meantion of three kinds of measure- linear, superficial as well as voluminal having the game epithet '*rajju*' or sulba This 'cord' is used to construct sacrificial altars as a measuring tape or like a building constructor who use cosd for proceeding to get the vertibral column

This śulba or measuring tape was prepared from *śana*[9] (a kind of hemp) or *balvaja*[10] or newly prepared from *muñja*[11] or *kuśa* The specification for the cord to be used for measuring length are given later in detail [12]

The term *śulba* did not occur in the Vedas The word "*rajju*" appeared in the Śatapatha Brāhmana [13] In śulbasūtras both the terms *rajju* and *śulba* are found to

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5 Sanskrit English Dictionary - V S Apte, P 560 शुल्ब (शुल्ब्) 10-U 1 To give, bestow 2 To send away शुल्बम् = A rope, string or sacrificial rite or act

6 शब्दशब्दश्च सनाहार्थकः Ā Ś S iii (नमो यज्ञाय) Preface

7 सख्यज्ञः परिमाणज्ञः समसूत्र निरच्छकः ।
समभूमौ भवेदिदा छुल्बवित् परिपृच्छकः ।।
का शु सू १-२ (महीधर वृत्ति) P 3

8 वैष्णवे या प्रमेयाय शुल्बविदभ्यश्च सर्वस्वः सख्यात्रभ्याः प्रवक्त्रभ्यो नमो भरन्तो यो मसे । 10 1 as 1b M S S

9 Biological name- *Cannabis Sativa*

10 Do = *Eleusine, Indica*

11 Do - *Saccharum muñja*

12 Chapter, 3 P

13 Sat Br 10-2-3 11

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occur The term *rajju* also appears in later works [14] Thus as per my observations the special word śulba occurs only in Śulbasūtras Thus śulba has special ideentity

Relating to the word śulba, I have already mentioned three words- (1) Śulba-vid (2) Śulba-vijñāna and (3) Śulba-paripṛcchaka [15] "Śulba-vid" which is mentioned in MŚS[16] taken this word in a geometrical way

वैष्णवे या प्रमेयाय शुल्बविद्भ्यश्च सर्वशः
संख्यात्र्यभ्यः प्रवक्त्रभ्यो नामो भरन्तो ये मशे ॥ *10 1*

इदं भूम्या भजामहे या नो मानकृतामिव ।
यज्ञियं मानमुत्तमॅ वर्धमानॅ स्वे दमे ॥ *10 1 11*

That means, 'according to the *vaisnava* (measure) the geometrician, the calculator, the dictator and the one who has taken up measuring as profession are always honoured by the "*Śulbavids*" ' There is no such word as "*Rajjuvid*" or "*Rajju-vijñāna*" Even in Śulbasūtras directly the word '*rajju*' occurs not Sulba in the explanation Therefore '*Śulba*' is not a mere a instrument of measuring If the '*Śulbavid*', means, geometrician, then śulba is the name of geometry itself In modern mathematics 'Geo' means arc or curve, 'metry' means correct perception or measurement [17] 'Geometry' is the title of the whole branch of mathematics about properties of stright lines, triangles, quadrilaterals, circles etc As I said already the word 'śulba' is not used which construction of sacrificial altars, in the same way, Geometry also usually not used in the play constructions The school course of geometry in mathematics deals with some properties of stright lines, triangles, quadrilaterals, circles etc Simulteneously 'Śulba' also deals with properties of stright lines, triangles, quadrilaterals, circling the squares etc In modern Geometry Pythagorus theorem, Value of π and surds like 2 and 3 are important, in the same

14 Artha śāstra of Kautilya, P 107

15 In the previous page

16 MŚS 10 1 11

17 'Hindu and Greek Contribution to Mathematic Sciences' Part I Preface, P 3

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way Śulba states the theorem of Pythagoraeus,[18] value of π and 2 [19] Śulba even gives rule for circling square and squaring the Circle[20] which is considered to be the higher Geometry With all these evidences, I may conclude that '**Śulba is the earliest Indian word of geometry and Śulba of Baudhāyana, Āpastamba, Kātyāyana, Mānava etc. are the books of geometry.**

Eventhough sūtra is the synonym for the word 'Śulba' that in the title 'Śulbasūtra', *sūtra* has a different meaning The wordsūtra means an "aphorism", or "a short rule" That means śulbas are written in sūtra style The importance of this style is described in following śloka

अल्पाक्षरमसन्दिग्धं सारवद्विश्वतोमुखम् ।

अस्तोभमनवद्यं च सूत्रं सूत्रविदो विदुः ॥[21]

Therefore, 'sūtra is a short rule' with limited words, but with brevity the like of which is not met with in the entire literature of the world This style has been developed to sum up only the pith of the learning in short sentences using nouns often compounded at great length and avoiding the use of verbs as far as possible This style of sentences used as memorial rule like rules and formulae in modern mathematics Therefore 'sūtras' of mathematics and 'sūtras' of 'śulbas' also have some similarities But mathematicians always give derivations or examples or proofs of thesūtras, whereas in the case of Śulbasūtrakāras given only the necessary formulae and statements of theorems and not the derivations of them [22] But now, mathematicians or modern English commentators like S N Sen & A K Bag have tried to give these derivations and proofs I have assimilated derivations and proofs of the those scholars wherever necessary

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18 B Ś S 1 12-14

19 Ā Ś S 1 6

20 B Ś S 2 9-11

21 San Eng Dictionary - V S Apte, Pp 610

22 Only commentators given explanation, not derivations (see Commentators' list in Appendix)

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Before analysing the subject matter of the śulbasūtras I will mention, in brief, the main contents in the Śulbasūtras, i e śulbasūtras of Baudhāyana, Āpastamba, Kātyāyana & Mānava I tried to locate some other manuscripts on these, in vain, I have given all sūtras of the above four śulbas in the Appendix [23]

The four śulbasūtras not only different in number of verses but also in subject matter Baudhāyana Śulbasūtra contains 323 verses distributed over 21 chapters Āpastamba Śulbasūtra 202 verses, 21 chapters, Kātyāyana Śulbasūtras, 67 verses, 6 chapters and Mānava Śulbasūtra, 233 verses, 16 chapters

Baudhāyana Śulbasūtra (B.Ś.S) :

Of all the extent Śulbas, that of the Baudhāyana is the biggest and is also, perhaps the oldest (It is discussed in the next chapter on date and time of the Śulbasūtras) It is divided into 21 chapters [24] The first four chapters contain 116 sūtras of which the opening two are merely introductory, sūtras 3-21 define the various measures, ordinarily employed in the śulbas, sūtras 22-62 give the more important of the geometrical prepositions necessary for the construction of the sacrificial altars, andsūtras 63-116 deal briefly with the relative positions and spatial magnitudes of the various *vedis* (or altars) The 5th to 7th chapter consists of 86 sūtras of which the major portion, sūtras 1-61, is devoted to the description of the spatial relations in the different constructions of the Agnis in general and the remaining portion, sūtras 62-86, elaborates the construction of the two simplest Agnis viz , the '*Gārhaptya-citi*' and '*chandas citi*' From 8th to 21st chapter, in altogether 323 sūtras, describes the construction of as many as 17 different kinds of 'Kāmya Agnis' of rather complex nature In case of some the description is quite elaborate and minute in details, but in other cases it is less so

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23 Appendix II

24 The Śulbasūtras of Baudhāyana, Āpastamba, Kātyāyana & Mānava Ed Indian National Science Academy, P 17-21

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2. Āpastamba Śulbasūtra:[25]

It is broadly divided into six patalas Of these the first, third and fifth are each subdivided again into these adhyayas and each of the remaining sections into four chapters So that altogether the work contains twentyone chapters and 223 sūtras The first section of the manual, chapters I-III gives the important geometrical propositions required for the construction of altars The second section IV-VII describe the relative positions of the various vedis and their spatial magnitudes Unlike Baudhāyana, Āpastamba here indicates briefly also the methods of their construction They are of course the particular applications of the general geometrical theorems taught in the earlier section The remaining sections of the Āpastamba Śulbasūtra comprising the chapters- VII-XXI deal with the construction of the Kāmya Agnis It is noteworthy that almost the same set of geometrical propositions are taught by both Baudhāyana and Āpastamba But the latter has treated of a smaller number of varieties of the Kāmayas then the former For instance Āpastamba teaches only one kind of '*Rathacakra citi*' (or the wheel shaped altar) where as Baudhāyana gives two

3. Kātyāyana śulbasūtras:[26]

In four śulbasūtras, this is the smallest It has other two names, one is Kātyāyana Śulba Pariśista other is Kātyāyana Śulba Pariśista It is divided into two parts The first part is composed in the style of thesūtras as those noted above, while the second part is composed in verses The earlier part is again subdivided into 7 kandikās (containing altogether 90 sūtras It teaches the geometrical prepositions, the different measures employed in the work and the relative positions and spatial relations for the different constructions of the Agnis This manual does not treat of the construction of the Kāmya Agnis It is because of that subject has been treated in a different chapter of the Kātyāyana Srautasūtra The second past comprises nearly about 40 or 48 verses It gives mainly a description of the measuring tape the gnomon, attributes

25 The four Śulbasūtras (Bau Āp Kāt Mān) Ed Indian National Science Academy, Pp 39-54

26 The four śulbasūtras (Bau Āp Kāt Mān) Ed Indian National Science Academy, Pp 54-57

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of an expert altar-builder and also a few general rules for his conduct Some of the processes of construction described in the earlier part together with a few other new matters, though of comparatively minor importance, also appear there I think the title Kātyāyana Śulba Pariśiṣṭa was originally designed for this part and should be kept reserved to it, even now For, it is really a short in appendix to the earlier part, the Kātyāyana Śulba is proper Kātyāyana observes that the second part, especially the recapiterlations in it, was meant to help those who intellects are too poor to be able to fully grasp the inner meanings of the compositions in the sūtra style Compared with the works of Baudhāyayana and Āpastamba, the Śulba of Kātyāyana presents some interesting features as it exhibits the whole body of geometrical knowledge required for the construction of the fire altars in a more systematic manner

4. Mānava Śulbasūtra:[27]

The śulbasūtra of Mānava is a small treatise composed in both prose and verse It is divided into 7 *khandas* In the first section, description is given on the measuring tape, the gnomon, measures, four methods of determining the cardinal directions and also a method of constructing square on a given stright line It may be noted that we do not find in the Āpastamba and Baudhāyana Śulbasūtras any method of determining the cardinal directions are already known Kātyāyana teaches three methods for the same, while Manu teaches as many as four The sections II-VI treat on the relative positions, spatial magnitudes and also the methods of the construction of the different *vedīs* But the *Pākayājñiki Mārutī* and *Vārunī vedis* which are not included in the above mentioned Baudhāyana and Āpastamba Śulbasūtra The last section of the Mānava Śulbasūtra furnished us with some hints about the sacrificial fires It also describes the method of the construction of the *suparna-citi* The citi is not find in other *Śulbasūtras* But for the head, its spatial magnitudes are the same as those of the most primitive citi, the *Saptavidha sārathi-pradeśa caturaśra śyena-citi*, described by Baudhāyana and others

27 The four śulbasūtras (Bau Āp Kāt Mān) Ed Indian National Science Academy, Pp 58-73

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5. Commentators on Śulbasūtras:

Several commentaries on the Śulbas are available now Some commentaries on Śulba are published while, some are unpublished (I have given a list of works on the Śulba, in the table - 2, Appendix I) More important manuals are found to have been commented upon by more than one commentator [28] We have two commentaries on the Śulba of Baudhāyana, three on Śulba of Āpastamba, six on Śulba of Kātyāyana and one on Śulba of Mānava The commentator of Mānava Śulbasūtra, Śivadāsa, son of Nārada, a resident of the city of Benaras not mentioned his name on the commentary [29]

We find in the text with the commentary on Śulbasūtra of Kātyāyana that Mahīdhara completed his commentary in the year 1589 A D at Benaras It is also stated there, that commentary is based on the Śulbasūtra-vrtti of Rāmachandra Vajapeyi The commentator was an inhabitant of *Naimisa* (near present day Lucknow) He seems to have been the author of several works such as *Karmadīpikā, Kundākrti, Śulbavārttika, Sānkhyana grhyapaddhati, Samarasāra* [30] The date of the *Śulba-sūtra-vrtti* of Rāma is given as 1450 A D Kapardisvāmi, commentator of Āpastamba Śulba quoted by Śūlapāni, Hemādri, Nīlakantha etc Now Śūlapāni lived near about 1150 A D He was the teacher of famous Sadgurusisya (1143-1193 A D), the author of the Vedārthadīpikā Hemādri was the minister of king Mahādeva of Devagiri and of his nephew and successor Rāmachandra (1271-1309) So Kapardisvāmi lived before the twelfth century of the Christian era [31]

Karavindasvāmi, commentator of Āpastamba śulbasūtra indeed wrote a commentary on the whole of the Śrauta-sūtra of Āpastamba His time is still very uncertain He is found to have quoted, without any mention of name, certain passages from the Āryabhatīya (409 A D) of Āryabhata - I (born 476) [32] So he undoubtedly

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28 See Bibliography, P

29 See Bibligraphy, P

30 Bhand O Inst No 74 of A - 1881-82 C V 41, Pp 42

31 Introduction Text with the commentary Śulba-vyākhya of Kapardisvāmi

32 Ā Ś S in 5 (com). the reference is to the Āryabhatīya, ii 9

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flourished after the 15th century of the Christian era [33] Though we are not in a position to fix or even suggest any closer upper limit to his time, this limit seems to us to be too earlier There is however, one passage in his commentary on the Āpastamba Śulba which might have taken him as belonging to a very early age I shall end with the notice of these commentators in brief But, there were also other commentators on the Śulbas anterior to these commentators who are unknown to us now Because, Kapardisvāmi himself referred to atleast one such anterior commentator. My focus is mainly on the subject matter of Śulbasūtras and not on the commentators

Ancient Indian Chronology and date of Śulbasūtras:

Chronology is the backbone of history and its knowledge is essential for historian dealing with any period, culture, area or subject There cannot be a coherent history without a chronological order

Unfortunately, in case of India the problem of chronology continues to be very serious, especially with regard to the pre-historic and ancient periods The dates of most of the important events and literary sources are full of serious controversies and divergent opinions [34] What to say about the absolute chronology when even a relative chronology is not free from challenges

Serious minded historians have always been worried about the chronic problem of Indian chronology, more about the very divergent views held by various scholars In 1950 the first significant symposium on history of sciences in South Asia was organised at Delhi by INSA[35] (which is also called NISI) At the very outset of the symposium, a chronology committee was appointed under the chairmanship of the noted historian R C Majumdar [36] It met on November 5, 1950 and after lengthy discussions, recommended the following chronological table as a working hypothesis

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33 Introduction Text with commentary, Śulba-pradīpikā of Karavindasvāmi

34 Gorakh Prasad, Bhāratīya Jyotisa (in Hindi) P 46-65

35 National Institute of Sciences of India

36 Proceedings of NISI, 18 (1952) P 331 Other members were A S Altekar, P C Bagechi, S L Hora, D S Kothari and A N Singh

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1	Age of the Ṛgveda	2000 B C -1500 B C
2	Age of Saṃhitās and Brāhmanas	1500 B C -800 B C
3	Age of Upanisads	900 B C -500 B C
4	Vedānga Jyoutisa (present text)	500 B C
5	**Śulbasūtras**	500 B C and later
6	Dharmasūtras	600 B C - 200 B C
7	Mahābhārata also Manusmrti and Rāmāyana	200 B C -200 A D

Recently research scholars have come to the conclusion that the Vedic Samhitas weic originated before 5000 B C

Through a systematic survey of Vedic literature and scientific records Navaratna S Rajarama and David Frawley have shown in their work 'Vedic Āryans'[37] and the origins of civilization as follows

i) Rg-veda reflects a maritime culture centred on the Sarasvatī river when it was still a flourishing river (Pp 105-135)

ii) Ṛg-vedic age must have ended much later than 3750 B C roughly coinciding with the introduction of silver in India (Pp 140-190)

iii) The so called Āryan invasion never took place - vedic civilization was predominantly an indigenous evolution (Pp 207-208)

iv) Harappan civilization, the name given to the vast civilization that stretched from the border of Iran to Eastern U P to Gujarat and Taptı valley, was the continuation of Vedic civilization of *sūtra* period (Pp 276)

v) The post vedic *sūtra* literature containing **the works of Baudhāyana, Āśvalāyana, Āpastamba & Kātyāyana must have been in existance well before 2000 B.C** based on a comparative analysis of vedic mathematics and the mathematics of old Babylonia (1700 B C) and the Egyptian Middle Kingdom (2000 to 1800 B C) combining this with

37 Vedic Āryans and the Origins of Civilization, P 9 Ed Voice of India, New Delhi

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astronomical data lends support to the traditional date c 3100 B C for the closing of the vedic age and the Mahābhārata war (Pp 289-300)

The resulting chronological synthesis as summerised by them in Table-5 against page 204 is given in the Table - 3, Appendix I

Thus considering the chronology given above we find that the Śulbasūtra might have been created between 500 B C to 200 B C Further, R C Gupta, in "Students Britanica"[38] has divided the available material into ten stages of the growth of mathematics in ancient and medieval India (See Table - 4, Appendix I) In this table third stage is the Age of Vedāngas or sūtra period which is 800 B C - 200 B C Therefore this chronology is very much useful in a systematic study of development of ancient Indian sciences By analysing the other Sanskrit sources also, we may predict the dates of Śulbasūtras, that I discuss now

The date of Śulbasūtras may be analysed with literary aspect also Bühler, Keith and other scholars tried to find out the dates of Śulbasūtras, Baudhāyana and Mānava, both have been considered definitely older than Āpastamba, as their archaic style of writing would indicate Mānava whose works were used by Āpastamba wrote more or less in the Brāhmana style and Richard Garbe considered his sūtra as the oldest, but, Keith points out, it was before the text of Baudhāyana was known

By considering the dates of later writers like Pānini, Kātyāyana and Patañjali, we may arrive at the dates of Baudhāyana and Āpastamba Here again, Pānini's date itself is debatable and no better debatable than other ancient texts Scholars are generally agreed that Pānini most probably lived in the fourth century B C The date of Kātyāyana who flourished after Pānini, Keith suggested 250 B C as the most probable date of Kātyāyana,[39] Bühler[40] considered Āpastamba anterior to Pānini by about 150-200 years, which would place the former in the 5th-6th century B C and

38 Students Britannica, Vol 6, Select Essays, New Delhi, 2000, Pp 321-324

39 Keith A B Veda of Black Yajurveda, Preface, clxiii to clxxii

40 Sacred Books of East, 12, xxxix

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with consideration of language it would not take him beyond, circa 300 or 350 B C Prof P V Kane in his 'History of Dharmaśāstra' dated Śrautasūtras of Baudhāyana, Āpastamba and Kātyāyana between 800 B C and 400 B C[41] One of the earliest Śulbasūtras, that of Baudhāyana contains long passages in the śloka metre[42] Keith in History of Dharmasūtra discussed elaborately regarding the date of Baudhāyana and Kātyāyana In Baudhāyana Darmasūtras, 23-25th chapters are śulbasūtras while in Kātyāyana Dharmasūtra 30th Praśna is śulbsūtras[r] Therefore we may consider Keith's opinion acceptable about the date of Śulbasūtrakāras Keith says,[43] the extant Baudhāyanadharmasūtra is certainly later than Gautama dharmasūtra, as it mentions, Gautama twice by name and also one quotation at least, in the latter Gautama Besides, Baudhāyana quotes by name several teachers on dharma, while Gautama quotes only Manu Bavel (11 7 15) quotes a verse which is itself an adoptation of a passage from Chāndogya Upanisad[44] If we compare Baudhāyana and Āpastamba, though both have numerous sūtras that agree almost word by word, the views of two writers shows that Āpastamba lays down stricter and more puritanic (and therefore later) views on certain points than Baudhāyana Gautama, Baudhāyana and Vasistha mention several secondary writers while Āpastamba is silent about them Gauthama and Baudhāyana approve the practice of *niyoga* (II 2, 17, 62) while Āpastamba condemns it (II 6 13 1-9) Āpastamba Śulbasūtra contains more Pāninian forms, more uncouth constructions, more words on archaic sense than in the case of Baudhāyana The style of Baudhāyana is simpler For example, to divide a line of a given length into any number of parts of equal length Baudhāyana śulbasūtra says- प्रमाणात् द्विगुणात् रज्जुमुभयतः पाशां कृत्वा मध्ये लक्षणं करोति । स प्राच्यार्थः । अपरस्मिन्नर्धे चतुर्भागोन लक्षणं करोति । B Ś S 1-30-32 while Āpastambaśulbasūtra explains- प्रमाणमात्री रज्जुमुभयतः पाशां करोति । मध्ये लक्षणमर्धमध्यमयोश्च पृष्टयायां रज्जुमायम्य पाशयोर्लक्षणेष्विति शङ्कु निहत्य उपान्त्ययोः पाशै प्रतिमुच्य

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41 History of Dharmasūtra, P 52

42 The third verse of Baudhāyana contains long passage

43 The Baudhāyana Dharmasūtra, P 49

44 Baud अथाप्युदाहरन्ति- यथा हि तूलमैषीकमग्नौ प्रोत प्रदीप्यते । तद्वत्सर्वाणि पापानि दह्यन्ते ह्यात्मयाजिनः । Compare छान्दोग्योपनिषद् V 24 3 तद्यथैषीकातूलमग्नौ प्रोत प्रदूयतैव हास्य सर्वे पाप्मानः प्रदूयन्ते ।

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मध्यमेन लक्षणेन दक्षिणापायम्य शङ्कुं निमित्तं करोति। ĀŚS I - 13-14 By comparing the sūtras of Baudhāyana and Āpastamba, Āpastamba śulbasūtras have a lot of similarity with those of the classical Sanskrit For example, in Baudhāyana समचतुरस्रं दीर्घचतुरस्र चिकीर्षतंस्तदक्ष्णयापच्छिद्य भाग .... while in Āpastamba समचतुरस्रं दीर्घचतुरस्रं चिकीर्षन् यावच्चिकीर्षेत् नावती पार्श्वमानीं . . 3 1, here the word 'चिकीर्षन्' is those of the classical Sanskrit word while चिकीर्षतं is vedic style So we may predict that Baudhāyana śulbasūtra is older than Āpastambaśulbasūtras (P V Kane, in 'History of Dharma shastra' prepared to place Baudhāyana Dharmasūtra between 600 B C to 300 B C[45] and Āpastamba Dharmasūtra between 450 B C to 350 B C[46] and Dr Ram Gopal[47] in his Ph D thesis 'India of Vedic Kalpasūras' (1959) placed Baudhāyana between 500 B C and 200 B C. while, Āpastamba between 600 B C and 300 B C[48] In 'Marāthi version' of 'Four Śulbasūtras', Warnekar S classfies dates of several śulbasūtras as follows

Baudhāyana, Vadhūla	800 - 500 B C
Mānava, Āpastamba	650 - 300 B C
Kātyāyana, Varāha	300 - 400 B C[49]

A K Bag in "Mathematics in Ancient and Medieval India"[50] assigned to the date of Śulbasūtrakāras as mentioned above M Subodh Kapoor in his book 'Ancient Indian Sciences' listed the dates of some of the landmark incidents as below

4000 B C - Rg Veda, 3700 B C Battle of Ten Kings (referred to in the RgVeda) Beginning of Puranic dynastic lists Agastya, the messanger of Vedic religion in Dravidian country 3600 B C - Yajus-Sāma-Atharvavedas Completion of Vedic Canon, 3100 B C -Age of Krishna and Vyāsa Mahābhārata War, Early

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45 History of Dharmaśāstra , P 52

46 Id , P 70

47 Indian Vedic Kalpasūtras, P 76

48 Indian Vedic Kalpasūtras, P 75

49 चार शल्बसूत्रे, Preface, P 14

50 Mathematics in Ancient & Medieval India, P 5

Indological Truths

Mahābhārata 300 B C - Śatapatha Brāhmana-Śulbasūtras-Yājñavalkyasūtras-Pānini, (Author of Astādhyāyi)-Yāska (author of the Nirukta)

The Śulbasūtras of Baudhāyana, Āpastamba, Kātyāyana & Mānava of Hindi Edition, edited by Dr Sathyaprakash (1965) assigned the dates of Śulbasūtras as follows

Baudhāyana - 800 B C Mānava - 750 B C Āpastamba - 600 B C Kātyāyana - 300 B C[51] G U Thite in 'Itroduction of Āpastamba śrautasūtras',[52] Āpastamba might have lived not later than 5th century B C Dr R P Kulkarni[53] considered Śrauta period as 400 B C to 200 B C and the period of Baudhāyana śrautasūtra is 800 B C The latest Śulbasūtra is that of Kātyāyana, 200 B C[54] Since Śulbas have been developed as an adjunct to different śrautasūtras and Dharmasūtras, the date of Śrauta and Dharmasūtras may be considered as the date of Śulbasūtras also Mr Amulya Kumar Bag[55] considered that the śulbasūtras have been developed in between 600 B C and 300 B C since it is the period of Śrautasūtras

The foregoing discussion will make it abundantly clear that we are still far from narrowing the date range differing by centuries and putting the early sūtra works on a firmer chronological order with respect to the age of śulbasūtras Baudhāyana and Mānava, have been considered definitely older than Āpastamba Mcdonell in his Brhaddevatā[56] favoured a date 350 B C for Kātyāyana should be after Baudhāyana, Mānava and Āpastamba After these famous four Śulbasūtrakāras, Hiranyakeśi, Varāha, Vādhula may be positional on a firmer chronological basis By now the names of about a dozen śulbasūtrakāras are known[57] They are Baudhāyana,

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51 The four शल्बसूत्राs, By Sathya Prakash, 1995

52 A Sru S , Introduction, Preface, P iii

53 Geometry According to Śulbasūtra, Preface, P xi

54 Geometry according to Śulbasūtra, P 113

55 History of Science and Technology in India, P 289

56 Vedic Index, 1, P xxii

57 The History of Mathematics and Mathematicians of India, P 20

Indological Truths

Āpastamba, Kātyāyana, Mānava, Sathyasandha, Maitrāyaṇa, Vārāha, Vādhūla Maśaka, Hiranyakeśin, Vaikhānasa and Laugāksi No śulbasūtra attached to Rgveda and Atharvaveda saṃhita is available today One śulbasūtra namely, Maśaka attached to Sāmaveda saṃhita probably also compiled a śulba text attached to the Śrautasūtras of that school All other Śulbasūtras attached to the various schools of the Yajurveda Of them, 4 Śulbasūtras namely, Baudhāyana, Āpastamba, Vādhūla and Hiranyāksi of Taittirīya saṃhita, 2 Śulbasūtras- Mānava and Vārāha of Maitrāyani samhita and 1 Laugāksi śulbasūtra of Kāṭhak Kapisthala samhita, all three samhitas attached to Krsna Yajurveda are found mentioned, But one Kātyāyanaśulbasūtra attached to Śukla Yajurveda (See the Table - 1, Appendix I)

Out of these Śulbasūtras scholars consider four very important They are- (1) Baudhāyana Śulbasūtra, (2) Āpastamba Śulbasūtra, (3) Kātyāyana Śulbasūtra, and (4) Mānava Śulbasūtra I could get only these four Śulbasūtras in printed form [58] (See Appendix II)

Place of Authors of four Śulbasūtras:

Place :

There is a good deal of uncertainty and differences of opinion about the place of Śulbasūtrakāras The Śrautasūtras and Śulbasūtras are silent about these questions In "Sacred Books of East" George Bühler who considered the question of place of Baudhāyana and Āpastamba was inclined to believe that both of them hailed from the Andhra region [59] He argued that the followers of Baudhāyana and Āpastamba had lived in South India since early times Baudhāyana manuscripts had been found in the south Mahārnava, an early work mentions that Andhra as the native place of Āpastamba Bühler also pointed out that the name of Āpastamba had been found on several land grants of the south and that both Baudhāyana and Āpastamba referred to in their Dharmasūtras to the manner and customs of the people of their inhabiting the northern parts of India In a large work on India of Vedic Kalpasūtras (1959) Dr

58 The four Śulbasūtras, by SEN & Bag

59 Bühler, SBE, 14 Pp xiii, 2, Pp xx

Indological Truths

Ram Gopal has shown that in the Śrautasūtras and Dharmasūtras, Baudhāyana gave simple evidence of his close familiarity with Āryāvarta, the place between the Ganga and Yamuna and its surroundings and Āpastamba with Kurupāñcāla country and its vicinity [60] About the places of origin of Kātyāyana Mānava, Baudhāyana and others nothing definite can be said

P V Kane[61] observes that Baudhāyanīyas are mostly confined to the South while Āpastamba's home was in the Northern part of India He said, "We know that Sāyana, the great commentator to the Vedas was a Baudhāyana A grant of Nandi Varma, a Pallava, of the 9th century mentions Brāhmanas of the '*pravacana-sūtra*' as receipients As Baudhāyana is called the '*pravacanakāra*' in the Grhaysūtra, Brāhmanas belonged to the Baudhāyana *carana* First Gotra, then sūtra and then the name of the donee are introduced in the grant Therefore as some of the donees are said to be students of '*pravacanasūtra*' It follows that "*pravacana*" stands for some sūtra school It appears that sūtra and *pravacana* are two different things whatever the later term may mean Baudhāyana is called 'pravacanakāra' and Āpastamba is styled '*sūtrakāra*' Baudhāyana *Grhyasūtra* itself mentions that Brāhmana who studied sūtra and *pravacana* was styled "*Bhrūna*" [62] Regarding the evidence of saying the Āpastamba's home was in North is about a number of words which are of rare occurrence in Sanskrit in particular to the sūtras of Āpastamba For example, in Āpastamba Śrautasūtra a word *ghoṭa* which having the meaning as horse (आज्यस्थालिं रौहिण्यकपाले च परिमण्डले घोडप्रकारे। ĀŚr S XV 3 12) घोड is used in Hindi in the same sense Therefore it employs ĀŚS most probably composed in North India However, with these type of evidences only it is not possible to conclude about the places of Baudhāyana and Āpastamba

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60 V K S, Pp 93-100

61 History of Dharmaśāstra, P 47 & 70-71

62 उपनीतमात्रो व्रतानुचारी वेदाना किचिदधीत्य ब्राह्मणः। एका शाखामधीत्य श्रोत्रियः। अङ्गाध्याचतूचानः। कल्पाध्यायी ऋषिकल्पः। सूत्रप्रवचनाध्यायी भ्रूणः - बौ गृ सू 1 7 2-8

Indological Truths

Chapter - 3

Units and Instruments according to Śulba and Śrauta Sūtras

Śulbasūtras give the relations of different units with each other 'Units' means the indication of the length of measurement The units of measurement occur commonly in the three Vedas themselves '*Angula*', '*Gavyūti*', '*Aratni*' and '*Yojana*' are mentioned in Ṛgveda [1] Yajurveda mentions '*Yojana*',[2] while '*Aratni*' and '*Vyāma*' are mentioned in Atharva Veda[3] So these units seems to be in use from a very early period But the length of these units are not mentioned clearly and it is not possible to find out whether the lengths indicated by these units in the early vedic period were almost same as given in different Śulbasūtras

In Upanisads a few units are mentioned In Katha Upanisad '*Anu*' is given as smallest unit [4] Possibly it does not have any relation to *anu* mentioned in BŚS (1-4) where fourteen *anus* are given as equal to one angula Another unit is given as '*Angustha*' in this Kaṭha Upanisad[5] itself which is not given in Śulbasūtras But the unit *Prādeśa* which is mentioned by Śulbasūtrakaras also mentioned in Chāndogya Upanisad[6] A very small unit and its very fine divisions are mentioned in Śvetāśvataro-panisad[7] and it is known as '*Vālāgra*'

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1 Aṅgula- Rv X 90 1, Aratni- Rv VIII 80 8 Gavyūti - Ṛv I 25 16, III 62 16 V 66 3 Yojana- Ṛv I 123 8, I 35 8

2 Yojana - Yv 16 54, 9 13

3 Aratni - Av XIX 57 5 Vyāma - Av VI 137 2

4 अणोरणीयान् महतो महीयान् । I 2 20 katha up

5 अङ्गुष्ठमात्रः पुरुषो । 2 4 12, 2 4 13, 2 6 17 Katha up

6 यस्त्वेतमेव प्रादेशमात्रमभिविमानम् । 5 18 Chā up

7 वालाग्रशतभागस्य शतधा कल्पितस्य च ।
भागो जीवः स विज्ञेयः स चानन्त्याय कल्पते ॥ – 5 9 Śve up

Indological Truths

It is obvious that the unit '*Vālāgra*' was not in actual use but may be an imaginery one and is mentioned here to show the very small size of the soul (जीवः) This unit may not be the same as '*Vāla*' mentioned in MŚS (10 1 4 2) Thus some of the units of Śulbasūtras may be found in Upanisads but they mentioned only in the contextual basis

Śatapatha Brāhmana contains several measuring units and their length were the same as indicated by the units of lengths given in Śulbasūtras As we find the units in Śatapatha Brāhmana are *Angula, Aratni, Prādeśa, Vitasti, Vyāma, Prakrama, Purusa, Yuga* and *Śamya* The length Angula is 24 anus (or 34 tilas) 1 aratni is 24 Angulas, 1 Prādeśa is 12 Angulas, 1 Vitasti is 12 Angulas, 1 Vyāma is 96 Angula, 1 Prakrama is 30 Angula, 1 Purusa is 120 Angula, 1 Yuga is 86 Angula, 1 Śamya is 36 Angula [8] Thus units of length measures for constructing the various sacrificial vedis and citis

Standard and derived units :

Units of measurements are divided into two catagories Standaid units and Derived units Standard unit is the one which is arbitrarily chosen like one foot and derived units are some proportions of standard unit like inches and yards By seeing the Śulbasūtras it seems that '*Angula*' is the standard unit for measuring lengths of different vedis, whereas '*purusa*' is the standard unit for measuring length of citis like *Śyena* and others All other units are derived from these two standard units

Bodhāyana[9] while giving the names and definations of different units begins

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8 i Angula - X 2 1 2-3
ii Aratni - VI 3 1 30,33, VI 7 1 14, VII 5 1 6,13
iii Prādeśa - VI 5 2 8, VI 5 3 17, VI 7 1 14, VII 5 1 14
iv Vitasti - X 2 3 14, X 2 2-8
v Vyāma - 1 2 5 14, VII 1 1 37, X 2 3 1
vi Prakrama - X 2 3 1, X 2 3 2, X 2 3-4-10
vii Purusa - X 2 3 11-12, 15, XIII 8 1 17-19
viii Yuga and Śamya - III 5 1 24, III 5-1 26-30

9 BŚS 1 3, 1 4

Indological Truths

with the defination of angula measure He gives measure of angula as equal to the length of fourteen grains of *Anu* or that of 34 grains of 'sesamum' when placed in contact with each other along their width, he had given names of other units and their measures as so many angulas which are as follows[10]

Derived Units

1 Ksudrapada	10 Angula	1 6
1 Prādeśa	12 Angula	1 7
1 Prth	13 Angula	1 8
1 Uttarayuga	13 "	1 8
1 Pāda	15 "	1 9
1 Aratni	24 "	1 16
1 Prakrama	30 "	1 15
1 Jānu	32 "	1 13
1 Śamya	36 "	1 14
1 Bāhu	36 "	1 19
1 Vyāma	120 "	1 20
1 Virāṭ	150 "	1 78
1 Iśā	188 "	1 10
1 Aksa	104 "	1 11
1 Yuga	80 "	1 12

Standard Unit : Aṅgula and Puruṣa:

Thus, according to Baudhayana, angula is the standard unit and other units are derived ones The angula measure must be constant as defined by Baudhāyana as its length defined by the width of *anu* or sesamum grains The width of the sesamum grains is fairly constant and their number (34) is large enough so that any slight variation in their width may get averaged giving a fairly constant length of the unit angula

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10 अथाङ्गुलप्रमाणम् ॥ 1 3 चतुर्दशाणवः ॥ 1 4 चतुस्त्रिंशत् तिलाः पृथुकाश्लिष्टा इत्यपर in BŚS 1 5

Indological Truths

Āpastamba[11] and Kātyāyana[12] did not find it necessary to give any defination of units of measures and their relations with each other The different units given in these Śulbasūtras must have been standardised and utilized to such a degree that these sūtrakāras may not have found it necessary to give this information At the time of Bodhāyana these units may have been standardised but he seems to be a systematic man and hence begins the Śulbasūtra with the difinations of different length measurements as an essential part of the geometry and layout of different Vedis etc that I have described in the following chapters

I think the unit of length to measure purusa is taken as standard one when measurements and layout of the *Kāmya citis* like *Śyena, Drona* etc In every Śulba sūtra before the layout of these citis is given, the method to determine the purusa measure is described Once the length of *purusa* measure was determined from the height of the sacrificer then the unit angula is determined The same units of measures are used with their length changed depending on the height of the sacrificer The angula obtained from the width of 34 grains of sesamum and other units derived from this standard unit of angula are constant On the other hand, the length of the standard unit of purusa used for measurement and layout of citis is not constant but is variable

With regard to surface measure, Bodhāyana says that, *mahavedi* measures 972 (sq) *pādas*[13] The *sautrāmanikı vedi* is 324 (sq)[14] *pādas* The corresponding references have unmistakably proved that the units denote square units and are meant for surface measure This has been verified by actual calculation Many references can be pointed out from the Śulbasūtras in favour of this

As regards volume measure, Śulbasūtrakaras were not clear enough since the question of volume was not considered as important In the construction of altars,

11 ĀŚS 15 4

12 KŚS 5 9

13 अष्टाविंशत्येनम् पदसहस्र महावेदि । BŚS 5 7

14 ĀŚS 5 8

Indological Truths

total height of the layers, i e practically the height of bricks of altars remains constant for a specific construction

Stalk of lotus and Aṅgula :

Baudhāyanaśulbasūtra had given the method of determining the length of the standard unit angula which is practical On the other hand, Mānavaśulbasūtra gives the smallest unit as the 'stalk of the lotus' and from that derives the length measure of angula in case the height of sacrificer is very small I think it is a pure imagination MŚS[15] described that the top of six enveloped lotus stalks are equal to a hair of three years old heifer Three such hairs are equal to a mustard seed The mustard seeds are equal to a grain of barley and six such barley grains put together sideways gives the length of one angula unit But BŚS and others would not have given the measures of stalk of lotus and that of the hair of a heifer He would have stated the length of angula equal to 12 mustard seeds or 6 barley grains

It is not understood as to the necessity of giving this different relations of grains with angula than that of given by BŚS The method given by Bodhāyana to obtain the length measure angula from the width of 34 grains of sesamum seems to be more accurate than that given by Mānava by using only six grains of barley as the large number of sesamum grains seems to increase the accuracy of obtaining the angula measure as already explained

The length of angula equal to the distance of the middle part of the middle finger of the sacrificer, is also given in MŚS This shows the detailed study of the measurements of different parts of the human body and it seems that the art of image making must be flourishing at the time of Mānava also This length measure of angula was standardised by the medieval period as ascertained from the treatiser of image making

It is to be noted that the length measure of angula described in the treatises of

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15 MŚS. 4 1-6 जन्मना रोमहीनो वा यजमानो भवेद्यदि । कथ तत्र प्रमाणानि प्रयोक्तव्यानि कर्तुभिः । यद्युरुतन्तु केशो वास्तृतः सर्षपो यवश्चैव षङ्गुणितः । षङ्गुणिनो भवति नरस्याङ्गुल माने तद् द्वादशक प्रादेशमित्याहुः । MSS 3 2 2

Indological Truths

the *Śilpaśāstra* is equal to eight grains of barley placed along their width in contact with each other[16] The length of the angula measure equal to 34 grains of sesamum or 14 grains of anu are not even mentioned in the treatises of *Śilpaśāstra*[17] The smallest length measure considered for developing the angula measure is paramānu which is equal to a dust particle seen moving about in the sun's rays that enter into a room through a perforation in a roof Eight paramānus make one *liksā* (a nit egg of a louse) Eight *liksās* make one *yūka* Eight yūkas make one mustard seed, eight mustard seeds when placed in contact with each other make one barley grain and eight barley grains placed along their width make one angula It is further mentioned that the angula measure obtained by placing six barley grains along their width is a small (*kanistha*) unit of angula One obtained by sereen barley grains is medium (*madhyama*) angula and eight barley grains make a standard angula This shows that the size of the barley grains might have decreased from the Vedic period to the medieval period or somewhat earlier date

Derived units:

The units other than angula and Purusa considered to be derived units in Śulba sūtras But there always be a relationship between Derived units and standard units as we seen in the Table - 6 & 7 (Appendix I)

Now let us see the different derived units of Śulbasūtras *Prādeśa*[18] is a main derived unit which is mentioned several times in various constructions of Vedis and citis This unit is not mentioned by Kātyāyana. According to others 1 *Prādeśa* is equal to 12 angulas But Mānava also given 1 Prādeśa as 10 angulas also I think this difference is due to the measurement in accordance with finger's height or difference in the width of sesamum Usually the difference between the length of first and second finger is measured as one *Prādeśa*

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16 See Table 5 Appendix I

17 See the Table - 6

18 अङ्गुलस्य प्रमाण तु षड्यवाः पार्श्व सहिताः । मा शु सू 44
द्वादशाङ्गुलस्तु प्रदेशः । – म शु सू 44
द्वादशे प्रदेशः । – बौ शु सू 17

Indological Truths

Vitasti is an another important derived unit and it is equal to 12 angulas [19]

Pāda Pāda is a unit of length which is equal to 15 angulas [20]

Aratni This is one of most usual derived unit mentioned in Śulbasūtras especially in the construction of various vedis The two *prādeśa* or two vitasti is usually called one aratni[21]

Prakrama Bodhāyana says two pāda is one Prakrama while Āpastamba says two or three pādas That means Prakrama is equal to 30 or 45 angulas [22]

Bahū or Shamya Three prādeśas are equal to one bāhu It is also called as Śamya which is equal to 36 angula

Vyāyāma/vyāma Four *Aratni* is named as *Vyāyāma* which is equal to 96 angulas [23]

Purus or Vyāma Five *aratnis* or 120 angulas is called as *Purusa* or *Vyāma* [24]

In Baudhāyanaśulbasūtra a very systematic information of all units are given But the varieities of units given by Kātyāyana was less in number (Table 6 & 7 gives the comparison of the different units and their relations in Baudhāyana, Āpastamba, Kātyāyana and Mānavaśulbasūtras If we compare four Śulbasūtras, some units have different relations with standard unit angula For example, in Baudhāyana and Āpastamba 1 *Pāda* = 15 *angulas* While in Mānava and Kātyāyana 1 *Pāda* = 12 angulas Similarly 1 *Bāhu* = 36 *angula* in BŚS While it is 42 angulas in MŚS

It is interesting that, instead of using any measuring scale as the standard unit measure of angula is equal to the length fourteen grains of Anu *(panicum miliaceum)* or that of 34 grains of sesamum when placed in contact with each other along with

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19 वितस्ति द्वादशाङ्गुलः । – मा शु सू 4 4
त्रयोदशाङ्गुलो वितस्तिः । – आ शु सू 6 3

20 पद पञ्चदशः षो शु सू 1 9 द्वै प्रादेशावरात्निः । बौ शु सू 1 1 6

21 द्विवितास्तिररात्निः मा शु सू 4 4 । द्विपदष्टः प्रक्रमः । बौ शु सू 1 15

22 प्रक्रमो द्विपदो त्रिपदो वा । आ शु सू 6 9

23 चतुररत्निः व्यायामः । बौ शु सू 1 21

24 पञ्चारत्निः पुरुषः व्यामश्च । बो शु सू 1 19

Indological Truths

width, he had given the names of other units and their measures as so many angulas The MŚS gives the measurement of 1 Purusa with respect to the height of a man (purusa) "A Man measures 120 angulas, according to his own limbs, but standing on his toes he measures 125 angulas "[25] KŚS also gives the unit of purusa as 5 aratnis, 10 vitastis, 120 angulas are equal to one purusa[26], but this seems to be not popular and the four Śulbasūtrakāras have taken the purusa measure equal to 120 angulas

The units Prtha and Uttarayuga given by BŚS seems to have gone out of use in later period, because it was not found in other Śulbasūtras, while Anūka, Urvasthi, Nābhi, Ārya was found only in AŚS These seem to have developed at the time of Āpastamba but later on they were not found as these are not mentioned in KŚS

It may be noted that except the units angula, prādeśa, vitasti, pāda, aratni and purusa, other units mentioned in Śulbasūtras were not in use in later period In samarāṅganasūtradhāra of king Bhoja the following units are mentioned [27]

1 Prādeśa = 9 angula 1 śaya = 18 angula

1 Vitasti= 12 angula 1 aratni = 1 hasta = 24 angula

1 Pāda = 14 angula 1 Vyāma = 84 angula

It is surprising that the unit 'hasta' which was very popular in later period as given in Śilpa texts is not mentioned in Sulbasūtras

The instruments:

As the name 'śulba' itself indicats, the main instrument of Śsulba sūtras was cord or '*rajju*' The other two instruments are (i) peg (ī) Bamboo-rod

Cord or Śulba or Rajju:

As I already explained dari, rajju, śulbasūtra have identical meaning in Sanskrit, used to mean a rope or a cord The word 'Rajju' is used in Vedas itself In Rgveda

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25 MSS 4 5

26 KŚS 5 9

27 Samarāngana sūtradhāra of Bhoja 9 1-9

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itself the word rajju is used to mean a rope[28] In Taittirīya Samhitā and in Atharva Veda also the word rajju was mentioned [29] As mentioned in MŚS ,[30] the cord was prepared from śama (a kind of hemp *cannabis sativa or Crotolaria Vuncea)* or balvaja (a kind of grass-*Eleusine Indica)* muñja (sedge like grass *Saccharum muñja)* and kuśa The cord has to be free from knotch (or be smooth) Its diameter should be even throughout its length There should not be any knot and should be prepared having such a strength that its length should not change when it is stretched with different pulling forces The length of the cord used for layout depends on the size of the Vedi, Citi and the method of constructing them

A cord usually longer than the required size was used in the Śulba for measuring line or surface [31] The land measuring or anything tied, was a common act in almost all the countries of the world The terms aksnayārajju (diagnol cord), Karani, tatkarani[32] (the side of a rectilinear geometrical figure) etc , clearly indicate lines drawn in different directions Since most of the measurements were done by the help of a rajju and surface measurements were in common among the Śulbasūtrakāras, it is quite probable that '*rajju*' had its use in land surveying Two different methods have been described for the measurements with cords as an instrument- (1) method of measuring by one cord (*ekarajjuvidhi*) and, (2) method of measuring by two cords (dvirajjuvidhi) [33] These measurements are explained in the next chapter

(i) Pegs (poles) The Sanskrit word '*śanku*' meaning a peg is used in Śulbasūtras Wherever the cord is to be fixed peg is used For example, in BŚS while constructing a square of sides of a given length, "the (east west) line (equal to the cord) is drawn

28 Rg I 162 8, 10 100 12

29 Tai Sam II 5 1 7 A V III II-8 VI 12 2
Units of length, measures given in different treatises of Śilpa Śāstra are given in Table

30 MŚS 10 1 1 1

31 KŚS 7 13 14

32 BŚS 1 45, 1 55

33 ĀŚ S 5 1 5

Indological Truths

and a pole is fixed at its middle The two ties (of the cord) are fixed in it (pole) and a circle is drawn with the mark (in the middle of the cord) Two poles are fixed at both ends of the diameter (east-west line)" [34] The word '*śanku*' is not a new word of Śulbasūtra as it is used in Ṛgveda, having the same meaning In Rgveda (1 164 48)[35] while explaining the construction of a chariot, it is said that three hundred poles are used for it "It is also mentioned in Aitareya Brāhmana[36] and Śatapatha Brāhmana [37]

(2) Bamboo-rod (Venu) The Sanskrit word 'Venu', means bamboo-rod, was another instrument other than cord and 'śanku' mentioned in Śulba sūtras Bamboo-rod is used only for the layout of the Kāmya citis like Śyena citis etc As Bamboo-rod would give correct length measurement with better accuracy than that given by a cord The use of bamboo as a measuring rod seems to be the development of Śrauta period, however Bamboo was known from Rgvedic period[38] and it is mentioned in Śatapatha Brāhmana also[39] But these references are not mention the use of bamboo as a measuring rod

The bamboo-rod used for measurement is mentioned only in Āpastamba and Mānava Śulbasūtra It is interesting to see that, in ĀŚS the bamboo-rod used as a compass also [40]

To construct a square, bamboo-rod is used as a compass "Two holes are made

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34 BSS 1 22, 1 23, 1 24

35 द्वादश प्रधयश्चक्रमेक श्रेणि नभ्यानि क उ तच्चिकेत ।
तस्मिन्त्साक त्रिशता न शङ्कवोऽर्पिताः षळिर्न चलाचलासः ॥

36 Aitareya Brāhmana, III 1 8 6

37 Śatapatha Brāhmana, III 5 1 1-4, III-5 2 2, III 6 1 3

38 Ṛg VIII 55 3

39 ŚBr II 6 2 17, VI 3 1 31, 32, I 1 4 19

40 AŚS 9 1

Indological Truths

(at the ends of a bamboo-rod at a distance equal to the height of the sacrifices with uplifted hands and third hole is made at the middle Having placed the bamboo-rod along the east-west line, poles are fixed in the holes from the western extremity, two poles from the western side are then taken off and a circle is drawn with the other end towards south-east"

Here a bamboo-rod of required length with three holes, two at the ends and one at centre, is used for the construction of a square instead of using a cord Circle of two different radii could be drawn with the help of a Bamboo-rod

In Mānava Śulbasūtras, several times, Bamboo-rod is used as measuring rod [41] Different lengths of Bamboo-rod mentioned in MŚS A bamboo-rod of measuring 120 angulas or 144 angulas or 132 angulas are used in order to construct different fire-altars

From the above description of the use of a cord or bamboo-rod along with a peg, we may conclude that, with such a simple instruments like cord or bamboo-rod Śulbasūtrakārs constructed wonderful Vedis, Citis etc which is really considerable and appreciable

For the layout of a Vedi, the length of a cord is specified as 214 angulas (i e 406 cms) [42] For a Mandapa layout a cord, as long as 18 aratnis (8 20 metre) is required Now a days, even though we have so many mathematical instruments, mathematicians, structural designers, sometimes making mistakes, but in the period of Śulbasūtrakāras, with the help of smooth, knot-frec '*rajju*' (or cord) without making any mistake, constructed wonderful drawings was greatest contribution of Śulbasūtras

Yajñāyudha or Tools of Yajña and its importance

The Brāhmana texts,[43] not only specify the mantras that must be recited and precisely indicated the acts that must be performed in several sequences, but also

41 MŚS 5 2, 5 3, 5 5, 5 6, 5 7, 5 10, 5 11

42 ĀŚS 6 17

43 Aitareya Brāhmana, 34, 1

Indological Truths

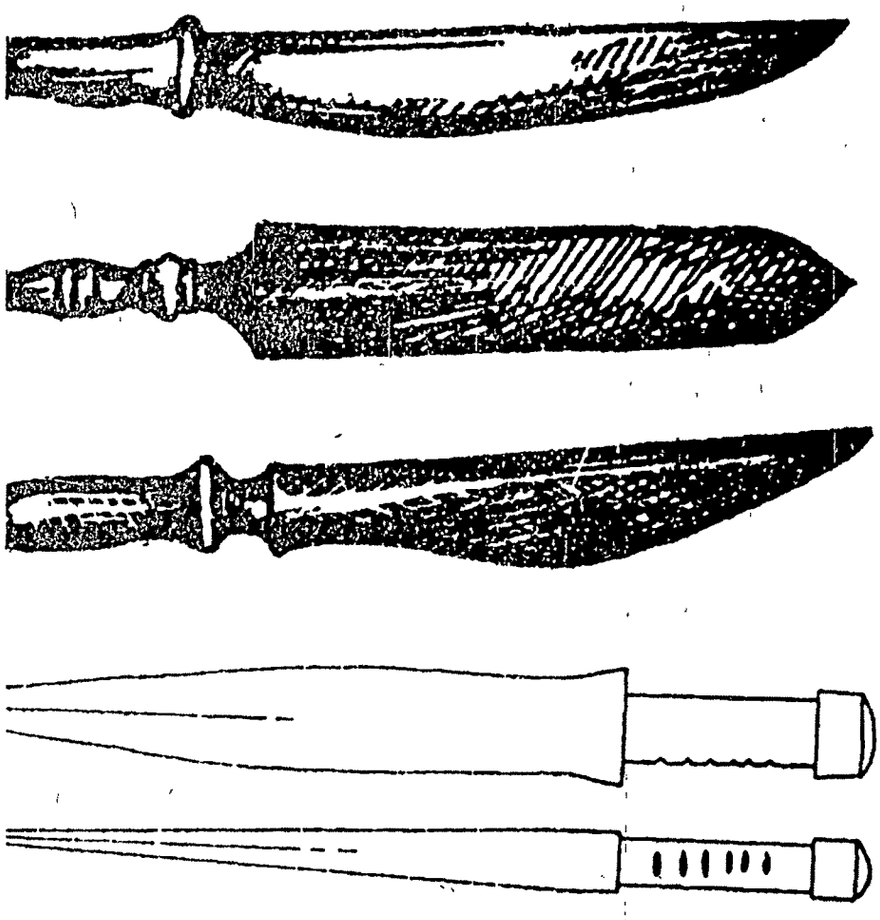

Fig. 1 - SPHYA -

Indological Truths

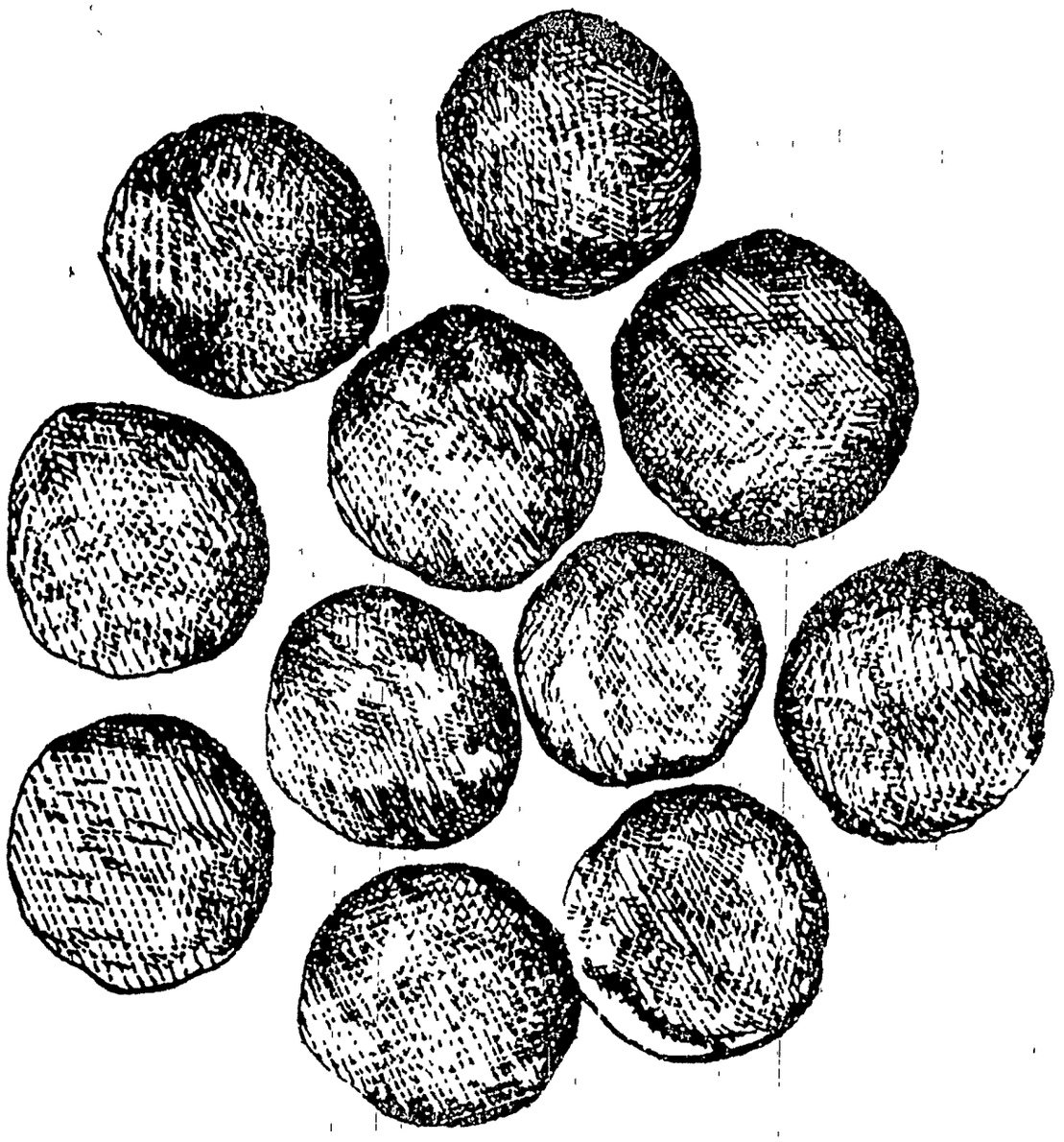

Fig ② & ③ Kapālas

Indological Truths

prescribe the forms and functions of the furnitures, vessels, utensils, implements and other articles that are used in sacrifices Most of them are wooden and the trees from which wood may be had to make them are also specified[44] These vessels or utensils and implements are collectivelly called Yajñāyudha or tools of Yajña

Taittirīya Samhita (1, 6, 8, 2 and 3) enumerates ten main tools of Yajña, which are very much essential in performing sacrifices They are-

यो वै दश यज्ञायुधानि वेद मुखतोऽस्य यज्ञः कल्पते स्फ्यश्च कपालानि चाग्निहोत्रहवणी च शूर्पं च कृष्णाजिनं च शम्या चोलूखलं च मुसलं च दृषच्चोपला चैतानि वै दश यज्ञायुधानि ।

1) SPHYA It is a wooden knife, but its shape is like a sword (khadgākāra) used for cutting the darbha grass to a required size[45] for making the lines in the sacrificial ground and for stirring the boiled oblations Usually this *sphya* is made of Khadira wood[46] *(Acacia catechu)* and is a cubit long (24 angulas) sometimes, in sacrifice no separate altar is constructed, the natural ground itself used as altar Here the sphya is used for removing the surface soil (uddhānana)[47], digging the earth (Khanana) and marking the area of the altar (parilekhana) [48] In varieties of the sacrifice like Rājasūya (like maitra-bārhaspatyesti) no separate altar is constructed, the natural ground is used as altar Here the sphya is used for removing the surface soil Usually in the apāraruma devayajanam The altar digged out two angulas or three angulas or four angulas deep

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44 Usually the trees are Palāśa, Khadira, Udumbara
स्फ्यः शम्या प्राशित्रहरणमिति खादिराणि । – आ श्रौ सू 1 15 13

45 स्फ्यश्च खादिरः खड्गाकृतिः अरत्नि मात्रः । – का श्रौ सू 1 3 33

46 वेधुधानन साधनम् – Ta Sam 1 6 8 5

47 यन्मूलमतिशेते स्फ्येन तच्छिनत्ति न नखेन ।। – ĀŚr II 3

48 अपारुमदेवयजन पृथिव्या अदेवयजनो जहीति -
स्फ्येनोत्तमा त्वचमुद्धन्ति ।
देवस्य त्वा सावितुः प्रसव इति खनति स्फ्येन वेदिं परिलिखन् परिगृहाति । – ĀŚr S II 3, P 62

Indological Truths

or as deep as the white portion of the heal a *prth* whatever root remains on the altar, cut it by means of the wooden sword (**sphya**) and not by means of nail The different types of *sphya* are as shown in the figure - 1

2 Kapāla Thin earthern platters of small size and round in shape on which the *purodāśa* cakes are baked for offering are called as Kapālas[49] The Kapāla is placed on the fire and the *puroḍāśa* is stored in a contained called '*ida*', while making oblations, clarified butter (*ājya*) is poured on the cakes [50] Kapāla may be one fourth size of our hand

Puroḍāśa is prepared out of a heap of paddy Four fist-fulls are taken and cleaned in a wicker basket (nirvāpa) It is then pound (*avaghāta*), dehusked and powdered, it is mixed with water and laid flat on the Kapāla, in the shape of a tortoise[51] as in figure - 2 Different gods are represented with *purodāśa* offerings separately on Kapālas Texts prescribe the number of *Kapālas* for each god Varuna, for example, is eligible for one Kapāla, the Aśvins two *Kapālas*, Vishnu three, Agni eight, Agnā-vaisnava (Agni and Visnu together) eleven and Agni-Somīya (Agni and Soma together) also eleven[52] and one potsherd for Dyāva-prthivī The different Kapālas are as shown in the figure - 3

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49 पुरोडाशाभर्जनार्थ मृत्तिकया निर्मितानि वह्नौ परिपक्वानि द्व्यङ्गुलोच्छ्रयाणि यस्मिन् पुरोडाशे यावन्ति विहितानि तानि कपालानि । का श्रौ सू 1 8 30

50 कपालानि नूतनस्य भिन्नस्य मृण्मयस्य पात्रस्य शकलानि पुरोडाशाधिप्रयणयोग्यानि । शाख्या श्रौ सू 1 8 वैजयन्त व्याख्या द्यावापृथिवी एककपालम् । – ĀŚr S V 1 29 10

51 आग्नेयमष्टकपाल निर्वपेत् ।
ऐन्द्राग्नमेकादशकपाल निर्वपेत् । – Ā Śr S IX 1 19 25
वैश्वानर द्वादशकपाल निर्वपेत् ।
आग्नवैणवमेकादश कपालम् । – ĀŚS VII 1 3
कापल mentioned several times in ĀŚSu I 14 8, 15 4, 20 11, 22 3, 6, 24-6, 25-3, II 10 4 II 3, III 1 4 4 15 1, 6 8, 16 5, 17 6, V 19 1, 22 1, 6, 23 5, 6 2 6 4, 28 1 2, 29 9 VI 3 7, 29 7, 9, 10, 20

52 अग्निहोत्र हवणी उपवेष च । – ĀŚS I 11 5

Indological Truths

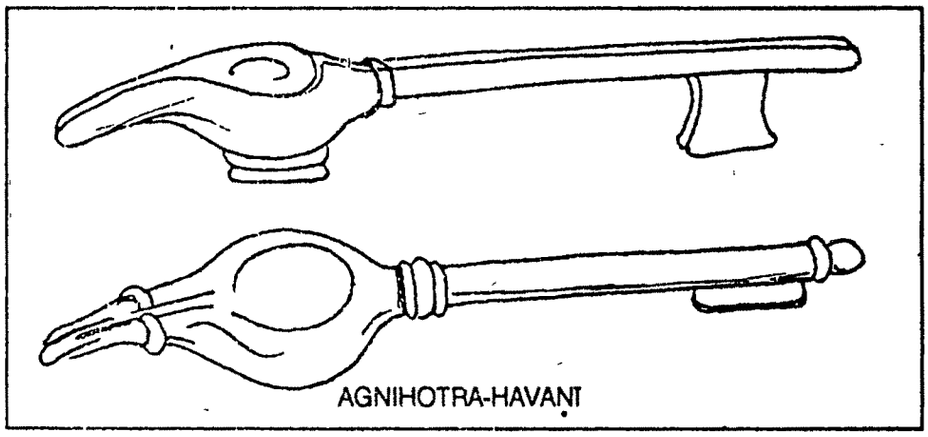


Fig ④

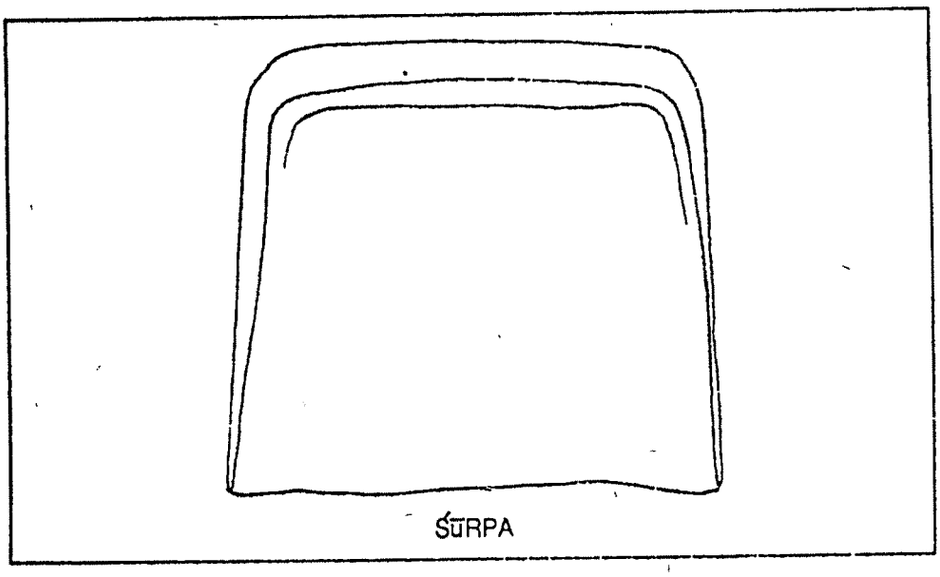


Fig ⑤

Indological Truths

3 Agnihotra - Havani A large wooden sacrificial ladle used for making oblations into the fire [53] It is a variety of 'sruk' and is prescribed to be made in vaikankalā *(Flacourta sapida)* wood It is one bāhu (i e 36 angulas) in length In Śulbasūtra the different types of Havanis are mentioned Some of them are Ājya Havani, Prsadājya Havani, Caru Havani, Anvāhārya Havani, Ukthya Havani, Āgrayana Havani, Dhruva Havani etc

In Āpastamba Śulbasūtra it is said that 'पवित्रान्तर्हितायामाग्निहोत्र हवण्यामप आनीयोदगग्राभ्यां पवित्राभ्यां प्रोक्षणीरूत्पुनाति देवो वः सवितोत्पुनात्विति प्रथमम् । i e with having applied water from the root-side upto the endside, having held the strainer in between them having poured water in the Agnihotra ladle he purifies the water with the strainers the ends of which are turned upwards Structure of Agnihotra havani is as in the figure - 4

4 Śūrpa. Flat winnowing receptacle (wicker)[54] square in shape with two corners on one side rounded off, and making a provision to hold the grains This is used for clearing the grains before they are ground and powdered [55] The material out of which this must be made is variously given as reeds (iśika), mango-leaves (āmra-patra), A *rundo libialis* (naḍa), long-stalked grass (kuśa) or cane (venu) Its prescribed size is also variously given 24, 20 or 18 angulas [56] (See the fig 5)

5 Śamyā:

A wooden peg or pin, stick or staff, shaped like a mace measuring a bāhu or thirtysix angulas It is a measuring device, used along with sphya[57] (which is used to

53 प्रसृताकृतिरार्यकृताग्निहोत्र स्थाली ऊर्ध्वकपालाऽचक्रवता भवति - आ श्रो सू 6 3 15

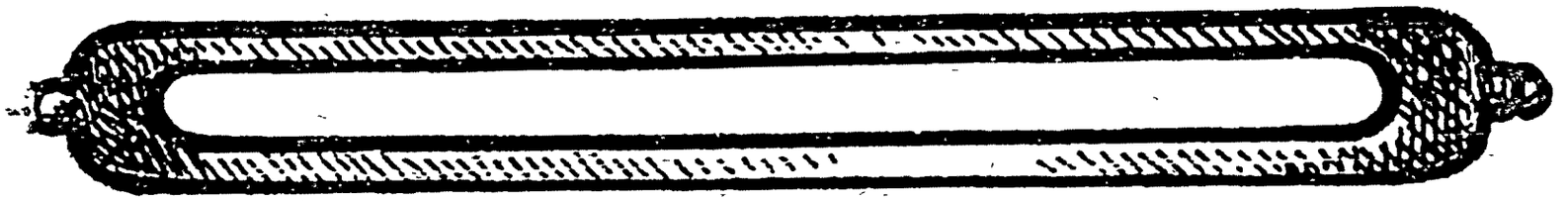
54 ऐषिक शूर्पम् । बौ श्रौत सू 5 5
उत्तरतः शूर्पमुपोहति वैणव मैषिक नलमय वा । भा शै सू 8 9 3

55 वेणु वेत्रकरीष केश्वकेन अरत्नि मात्राय त वृत्तमूलं विंशत्यङ्गुलि विस्तार अष्टादशाङ्गुलि विस्तार वा क्रमात् न्यून द्वयाङ्गुलग्र शूर्पम् । – अश्व श्रौत सू 11 9

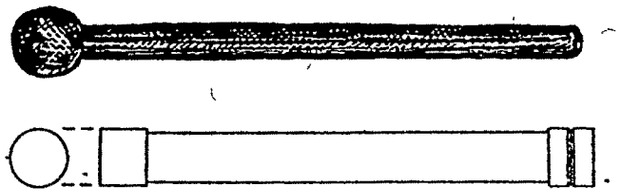
56 शाम्यं जहुवदायामा तथैव दण्डस्य मूलमग्रं च । दण्ड विंशत्यङ्गुलमूर्ध्वोऽग्रे चतुरङ्गुल दण्डायत कुर्यात् । वै श्रौ सू 11 8

57 स्फ्यः शम्या प्राशित्रहरणनिति खादिराणि ।

Indological Truths



Śamyā (Another type)
II



Śamyā II (in the shape of Cudgel)

Fig ⑥

Indological Truths

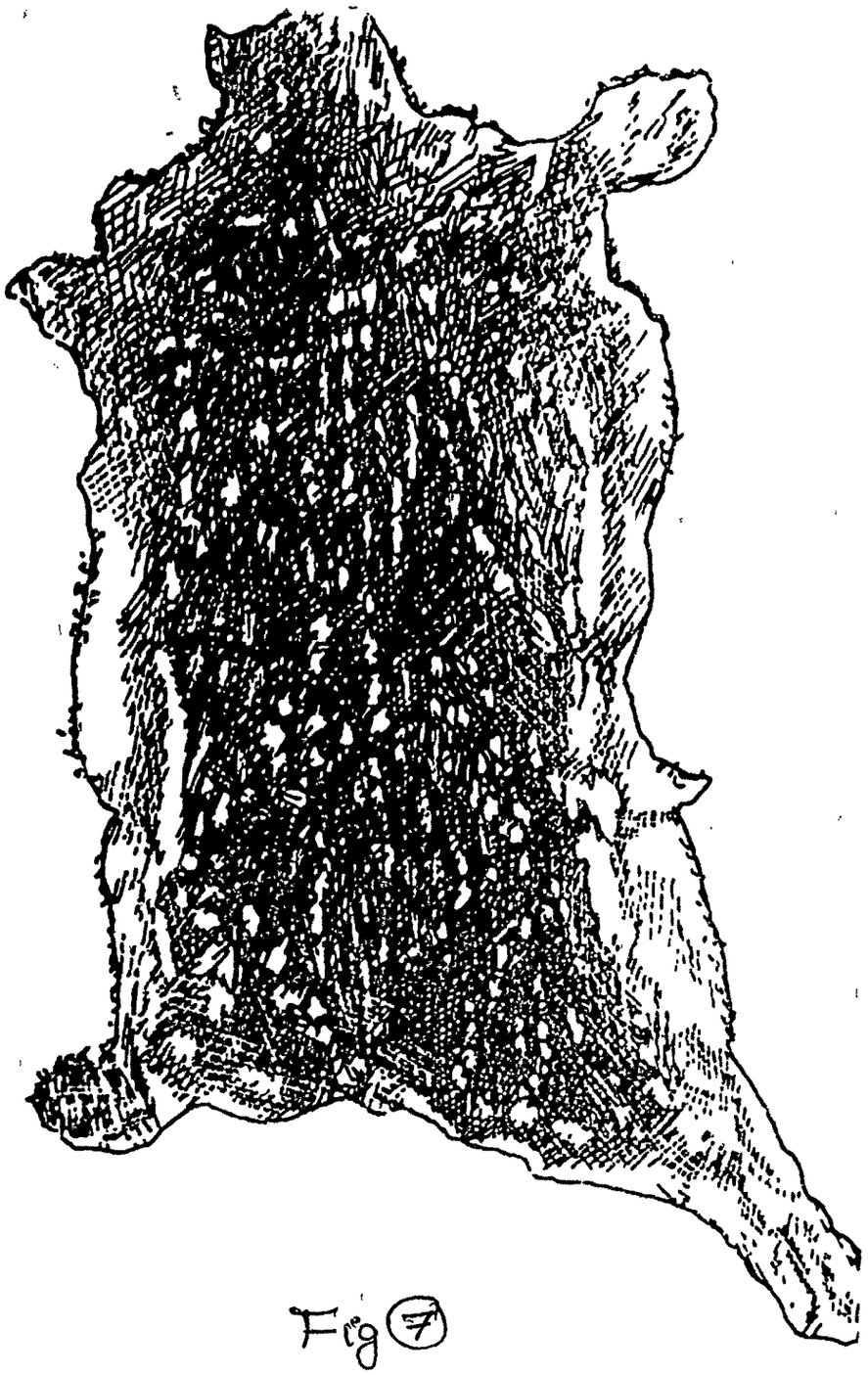


Fig (7)

Kṛiṣṇajina

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mark the lines) In this case there is a vertical slit in the Śamyā It is made of Khadira wood *(Acacia catecher)* or Vārana *(Crataeva rox burghii)*

This Śamya has a lotus shaped head with having 4 angula long as in the figure It is called as *Kuṃba* It is used to measure the sacrificial ground This is kept inside another Yajñāyudha named Drsad The ĀŚr S says Nirūdhapaśubandha should be of the measure of one Yoke-pin (shamyā) and also says- "On the eastern side (of the place where the Uttaravedi is to be prepared) having kept the yoke-pin with its point to the north, he traces a line (from the south) to the north" (ĀŚr S VII 3 13-14) (See fig 6)

6 Kṛṣṇājina:

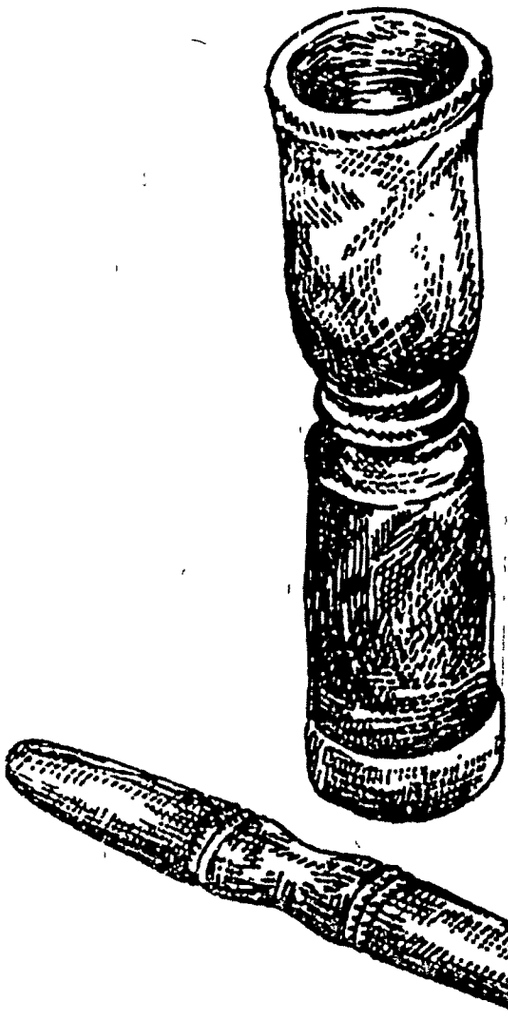
The black antelope's hide used in sacrificial rituals for the sacrificer to sit upon, and for the mortor (Ulūkhala) and pestle (musala, for pounding grains) to be placed on[58] It also figures during the consecration (dīksā) of the sacrificer in soma-yāga This 'Krsnājina' is the skin of a "Krsnamrga" and believed to be having auspicious While explaining the process before sacrificial ceremony ĀŚr S says "after washing the rice grains Adhvaryu pours the washed-water on the rubbish-heap At this stage ''अत्र कृष्णाजिनस्यादानादि प्रागधिवर्तनाकृत्वादिव स्कम्भनिरसीति कृष्णाजिन उदीचीनकुम्बां शम्यां निधाय धिषणासि पार्वत्येति ॥ आपू.श्रौ सू. 1 21 2-3 i e having done (the work) beginning with taking of the black antelope's skin upto the placing (of mortar on the Krsnājina) having placed the wooden peg with its thicker part pointing to the north (See fig 7)

7. Ulūkhala:

A wooden mortar, used for pounding the grains or crushing soma shoots, preparatory to oblations It is a cylindrical instrument with a bowel-like depression at the top and narrow in the middle But height for an Ulūkhala to be 12 angulas (one hasta) and its circumference is 24 angulas (two hastas) and its middle portion (Halla) is 8 angulas It is made up of Khadira *(Acacia catechu)*, Varana *(Crataeva rox burghe)*, Udumbara *(Ficus glomerata)* or any other sacred tree ĀŚr S records,

58 अथैव पुरस्तात् प्रतीचीनग्रीवग्रीवमुत्तरदोमोपरत्यणाति यत् कृष्णाजिते हरिरध्यवहन्ति । तै ब्र 3 2 5

Indological Truths



Ulukala

Musala

Fig (8)

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'without leaving the contact of the skin, he places the mortar on it Without leaving the contact of the mortar (by means of his left hand) he pours the oblation on it with 'agnestanūrasī', thrice with a yajus (formula) and for the fourth time silently [59]

The form of Ulūkhala is as shown in the figure - 8

8. Musala:

The pestle made of Khadira or palāśa, used for pounding the grains or the soma shoots placed in the Ulūkhala (mortar) It has an iron plate at its base It is prescribed to be three aratnis (= 24 x 3 angulas) in length and one muṣṭi in breadth As ĀŚr S states, with adrirasi vanaspatyah having taken the pestle (in his hand) with[60] haviskrdehi he strikes three times (the grains with pestle) (See fig 8)

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59 अनुत्सृजन्कृष्णाजिनमधिषवणमसीति तस्मिन्नुलूखलमधिवर्तयति । अनुत्सृजन्तुलूखलमग्नेस्तनूरसीति त्रिर्यजुषा तूष्णी चतुर्थम् । ĀŚS 1 19 6 7

(I) उलूखल हस्तोन्नत तस्य नाह द्विगुण परितो भित्तिद्व्यङ्गुलायत अष्टकशेष विस्तारायत बिल तस्य निम्न दशाङ्गुलम् । – वैखा श्रौ सू 9 8

(II) पालाशं जानुमात्र स्यात् पृथु बुध्नमुलूखलम् । अर्धखातं बृहद्वक्रं मध्ये रास्नासमन्वितम् । – पा गृ सू 1 2

(III) तत्र उलूखलमुसलो स्वायत्त प्रमाणे । – का श्रौ सू 1 3 37

(IV) खदिर मुसल कार्य पालाशः स्यादुलूखलः यद्वाभौ वारणौ कार्यौ तदभावेऽन्यवृक्षजौ । – देव यज्ञिकपद्धति (पु 6)

(V) इध्मोच्छ्रायमर्धखातं खातेनैव तु विस्तरः । मध्ये हीनं तथोर्ध्वग्र वारण तदुलूखलम् । – अथ प 23 2 2

(VI) प्रादेशमात्रं चतुःस्तक्तिः औदुम्बरमुलूखलम् उत्तरं असे प्रयुक्त । अपरिमित मुसलम् । आप श्रौ सू 29 1-4

(VII) हे उलूखल त्व अधिषवणस्य अधारभूत वनस्पतिजन्य चासि । – तै स 1 1 5, सायण भाष्य

60 अद्रिरसि वानस्पत्य इति मुसलमादाय हविष्कृदेहीति त्रिरवहन्ति । अनवघ्नन्वा हविष्कृत ह्वयति । Āp Ś S 1 20 8

(I) मुसल चतुर्हस्त यजमानायात वा । युक्तानाह मूलोऽयस्य निबद्ध एतौ यावतौ हविर्द्रव्यस्य अवघातयोग्यौ तावत्प्रमाणौ । – वै श्रौ सू 11 9

(II) खादिर मुसल प्रोक्तं अग्नित्रयसम्मितम् । – का गृ सू 1 2

(III) उलूखल मध्ये हति मुसलमवदधौति अद्रिरस वानस्पत्यः । – बौ श्रौ सू 1 6

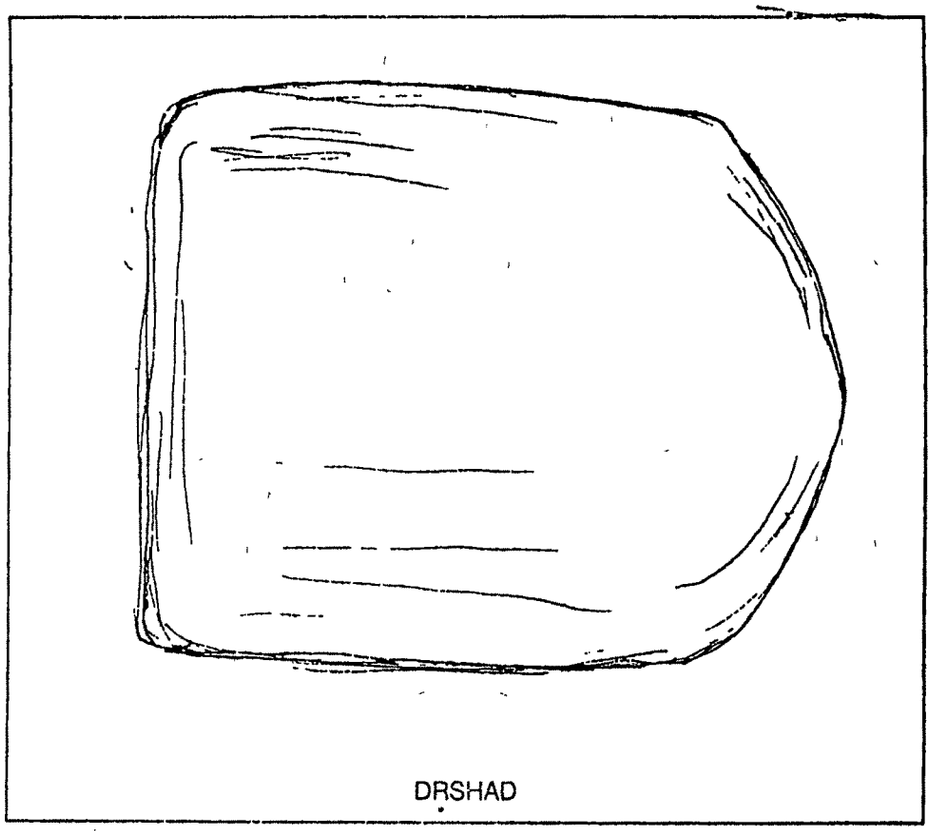
(IV) चतुरस्रमुलूखले मध्यसंग्रहीतं उर्ध्ववृत्त मुसल दक्षिणम् । – का श्रौ सू 17 5 2 (सरला व्याख्या)

(V) त्व वनस्पति जन्योरपि दार्ढ्येण पाषाणोटसि । – तै स सायण भाष्य 1 1 5

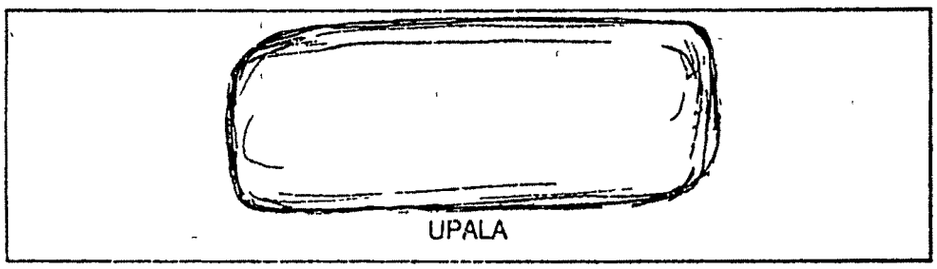
(VI) उलूखलमुसल औदुम्बरे प्रादेशमात्रे । – का श्रौ सू 17 5 3

(VII) वारण मुसल चैव अधस्ताल्लोह वेष्टितम् । – अथ प 25 2 3

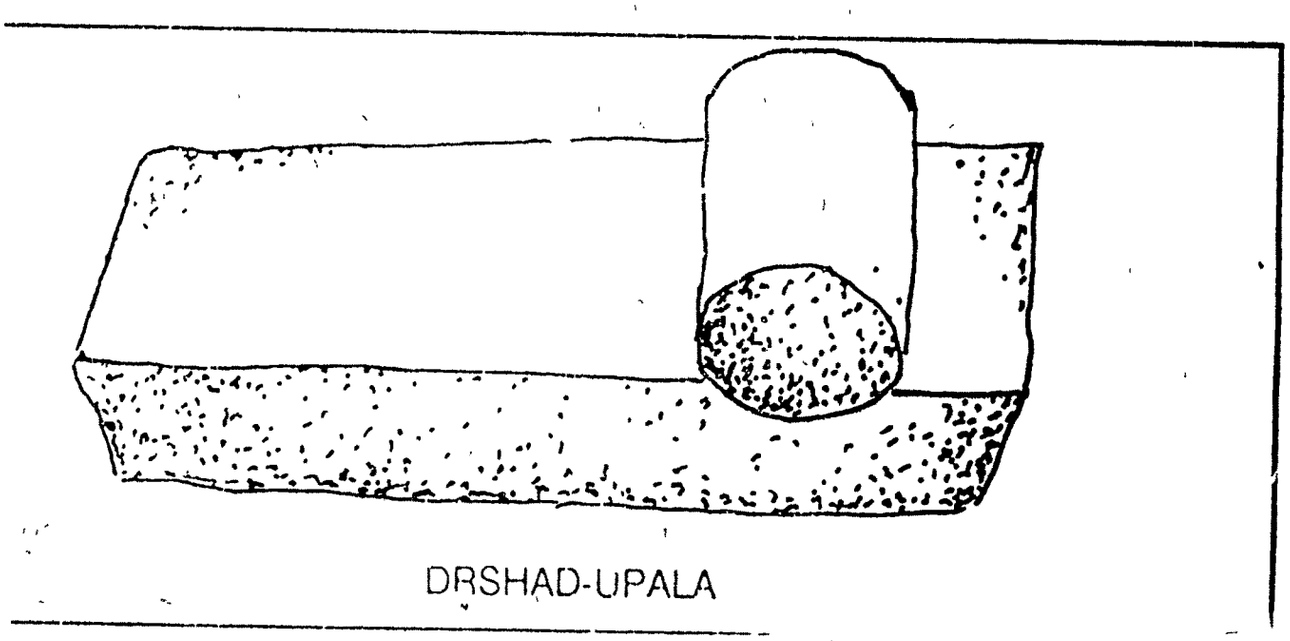
Indological Truths



DRSHAD



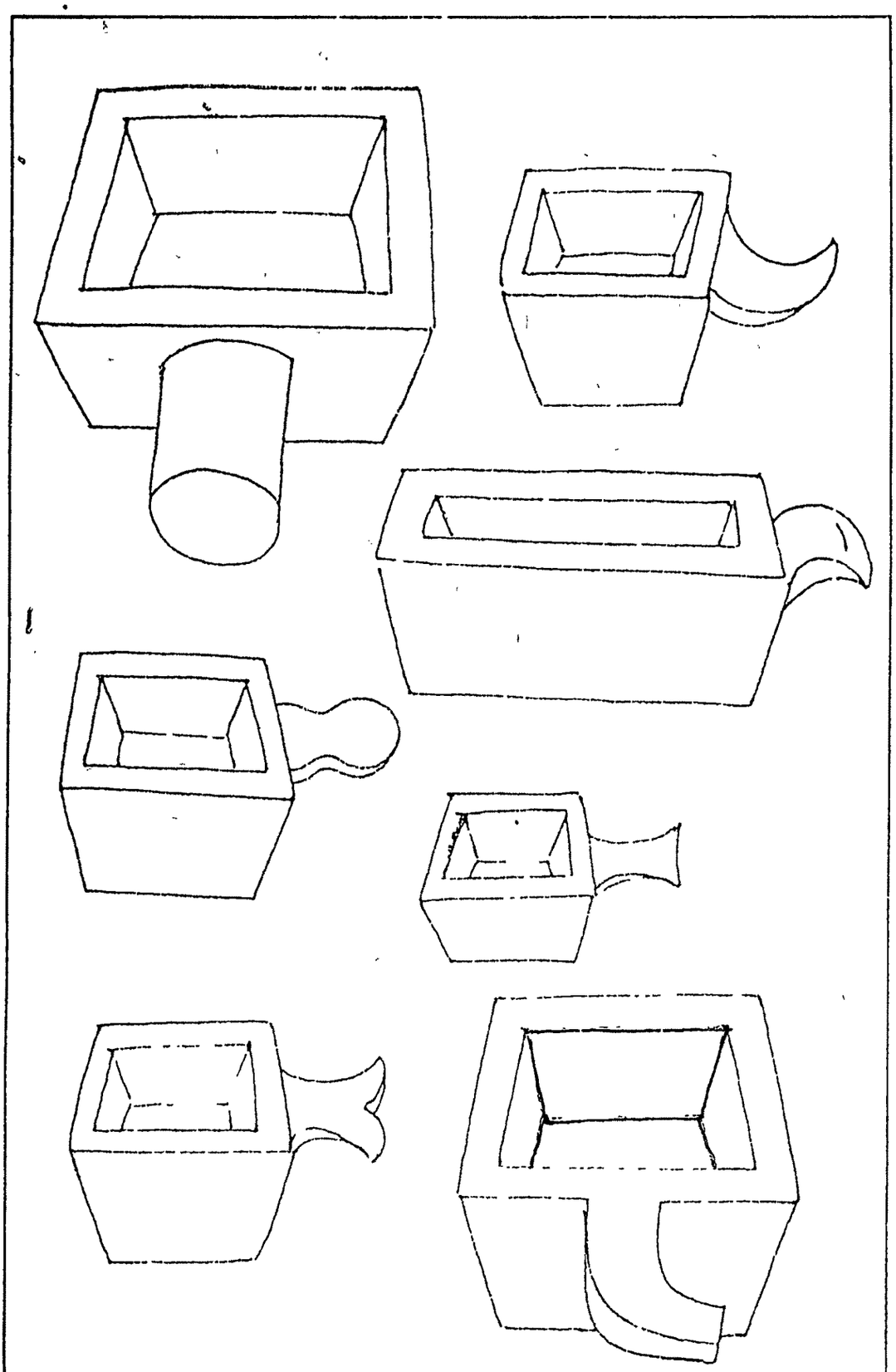
UPALA



DRSHAD-UPALA

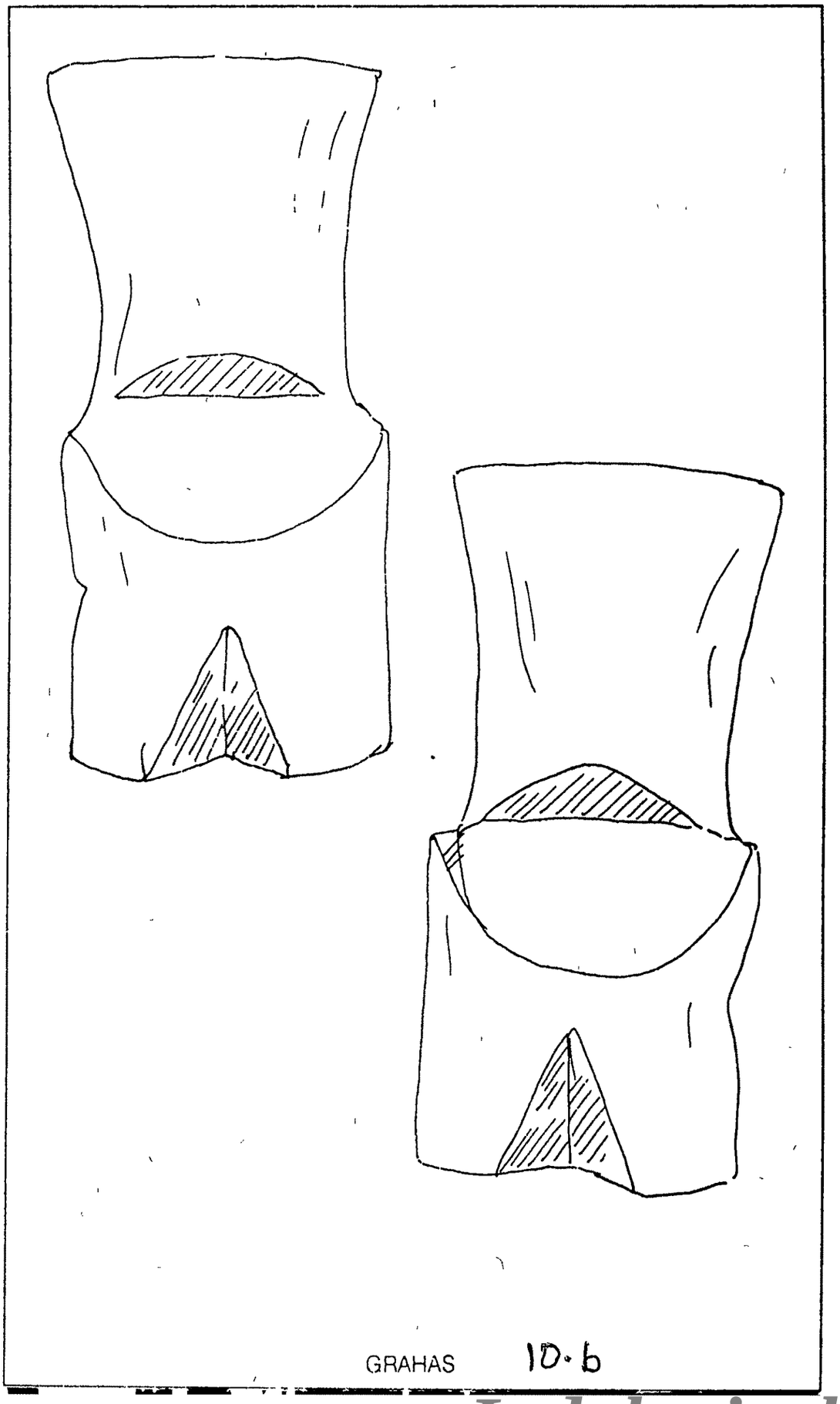
Fig 9

Indological Truths



CHAMASAS 10(a)

Indological Truths



GRAHAS 10.b

Indological Truths

9&10 Dṛṣad and Upala:

It is a large stone slab (pattah) on which are placed the soma-creepers, to be crushed or ground[61] with the help of upala as shown in the figure - 9

Upala is a smaller mill-stone resting on the '*drsad*',[62] is used for crushing or grinding the soma creeper Placed on the drsad, Upala is also called adri, while drsad is also called grāva These two are used in the soma-rituals, where the juice of soma is offered as oblation, and also for pounding the grains, for purodāśa-cakes ĀŚr S (1 21 3p 51), mentioned that "शम्यायां दृषदमत्याधाय धिषणापासि पार्वत्येति दृषद्युपलामत्या-दधाति । i e with mantra -*dhisanāsi pārvatya* (T S 1 1 6d) he places the upper stone on the lower stone प्राणाय त्वेति प्राचीमुपला प्राहेत्यपानाय त्वेति प्रतीची व्यानाय त्वेति मध्यदेशे व्यवधारयति प्राणाय त्वापानाय त्वा व्यानाय त्वेति सततं पिनष्टि । with '*prānāya tvā*' mantra, sacrificer moves forward the upper stone, with 'apānāya tvā' backward, with 'vyānāya tvā' he holds its in the middle part (of the lower stone) Then with 'prānāya tvā', 'apānāya tvā', 'vyānāya tvā' he crushes continuously

Besides these ten, which are specifically mentioned as tools of yajña, there are many other utensils and implements which are used in a sacrificial context, different kinds of ladles (sruc), a variety of containers (graha), bowls (sthālī), pitchers (kalaśa), cups (camasa), milk-pails (pinvāna), planks (phalaka), sickles (asido), hoes (abhri), hammers (vighana), tongs (śapala), fans (dhavitr), carts (śakaṭas) and stools or chairs (āsandi) (See some of them in the figures - 10a, 10b, 10c and 10d

The Brāhmana texts and the śrautasūtra manuals provide information on the form of a utensils or implements These implements are not only suited to the function, it was designed for, but were in accordance with some mystical symbolism of ritualistic significance

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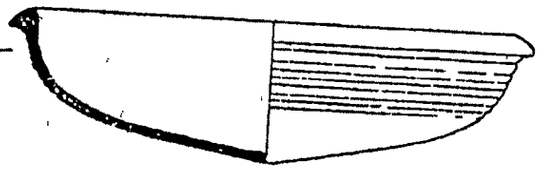
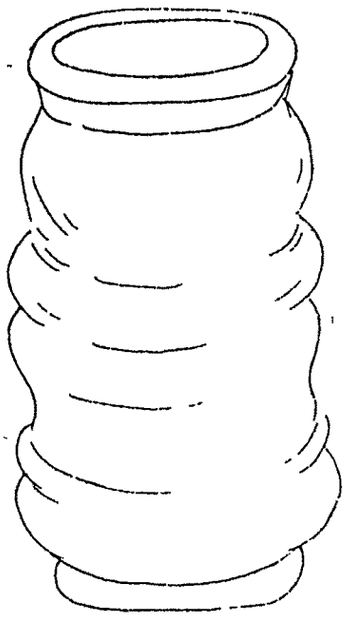
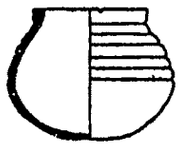
61 अथ दृषदमुपधाति शम्यामुदोचिनाग्रमुपदधति अथोपलामुपदधाति हविरधिवपति पिनष्टि ।
– श ब्रा 21 15 19

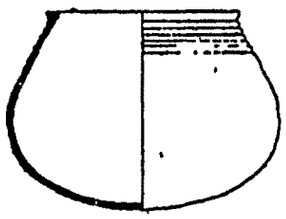
62 अधरा दृषद् ऊर्ध्वं उपल च । – आ श्रौ सू 9 11 16 (रुद्रदत्त भाष्य)

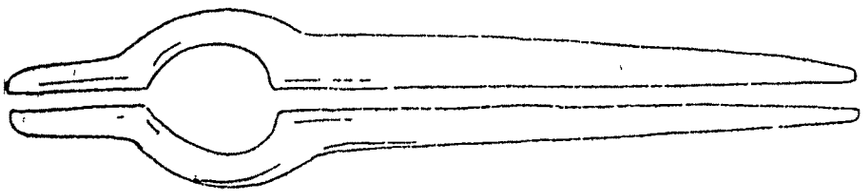
Indological Truths

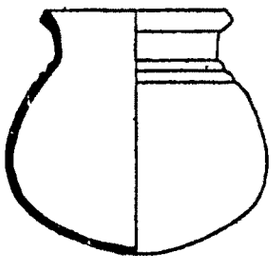




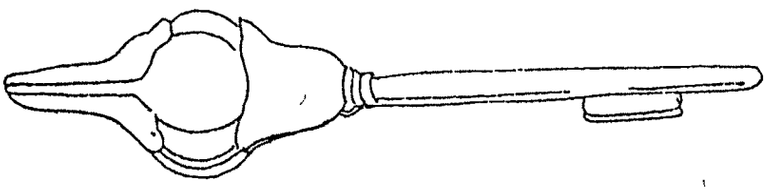






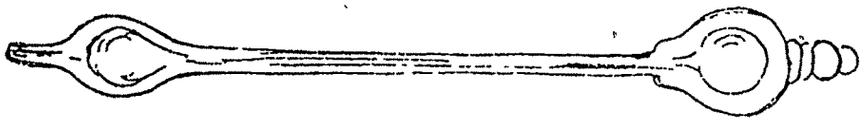


Sthālīs - 10c



10 d

MAHĀVĪRA, ŚAPHA, UPAYAMANI



VASORDHARA

Fig 11

Indological Truths

Vasor-dhāra:

This is one of the variety of ladle used in the Agni-cayana Vasor-dhārā is meant for continuous and uninterrupted, steady and uniform offering of melted clarified butter (ājya) Baudhāyana śrautasūtra[63] prescribes that its front half should be in the form of a sruk, but that the rear portion should accommodate a 'camasa' (or bowl) The purpose is to have a steady and continuous stream of offering The actual device has a long slender drain from the bowl to the beak (the implement being a vyāma or 96 angulas in length)[64] Sometimes two bowls are provided, for elegance and for ensuring steady supply, the rear bowl being larger than the front The offering symbolizes the unbroken stream of prosperity by returning the ājya[65] to Agni and through Agni to devata intended The form of the vasor-dhara is as in the figure - 11

The Yajñas have different forms in accordance with their sequence and objectives of the performers ladles, bowls, cups and containers, each of them have different forms which are discussed in detail as follows-

Sruk and Sruva:

The most common ladles used in Yajña are Sruk[66] and Sruva[67] Sruk is a long ladle, a bāhu (36 angulas), an aratnī (24 angulas) or a prādeśa (12 angulas) in length It is made of some wood like śami, aśvattha, palāśa or vikankata It will have a bowl or depression (puskara) on top of it at one end with a beak (shaped like elephants' lips or swan's beak) for the liquid to be poured out (prasecana),[68] the tail portion

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63. BŚr S. 10 54.

64 अग्नाविष्णू सजोषसेति चतुर्गृहीत हुत्वौदुम्बरी स्रुच व्यायाममात्री मृदा प्रदिग्धा पश्चादासेचनवती घृतस्य पूरयित्वा वाजश्च मे प्रसवश्च म इति सततां वसोर्धारां जुहोत्या मन्त्रसमापनम्। – ĀŚS XVII 17 8

65. अग्नाविष्णू इति वसोर्धारायाः। अपरं चतुर्गृहीतम्। – ĀŚS XIX 13 4

66 स्रुक् सम्मार्जनमेके। – ĀŚS II 4 P 67, स्रुव।

67 स्रुवेण पार्वणौ होमौ। सर्वाणि द्रवाणि स्तुञ्जुखेन जुहोति देवस्य त्वा सवितुः प्रसव इति स्रुक् स्रुवमादाय प्रत्यष्ट। – ĀŚS VI 7, I 240

68 पर्ववदाज्यलिप्ताभ्यां प्रोक्षणीरुत्पूयानिष्कासिना स्रुवेण वेदमुपभृत कृत्वान्तर्वेद्याज्यानि गृह्णाति ।। – ĀŚS II 7 1 2 73

Indological Truths

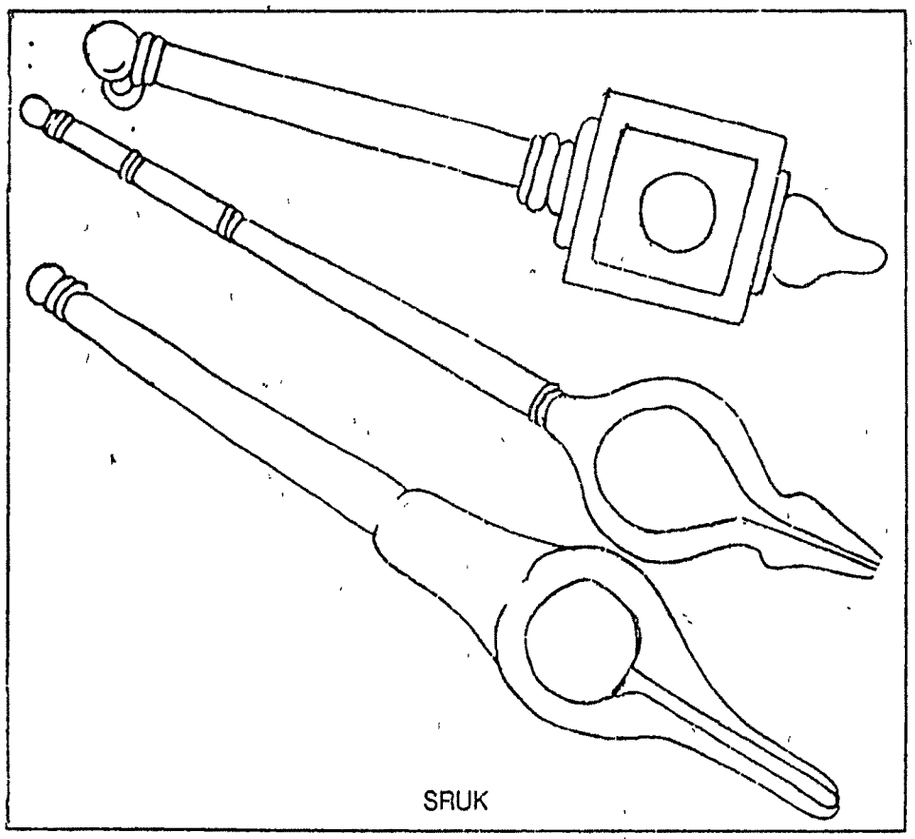

Fig 12

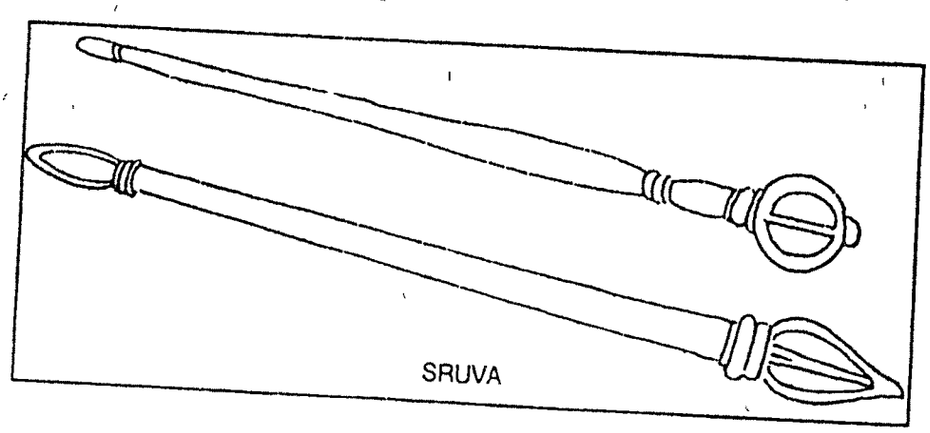

Fig (13)

Indological Truths

(or handle) of the ladle will be in the form of crow's tail (Vāyasa-puccha) There is a regulation that the front part (or handle) of the ladle will be in the form of crow's tail (Vāyasa-puccha) [69] There is also a regulation that the front part of the ladle should be the top portion of the wood, while the rear part should be the bottom portion (facing the root of the tree) as in the figure - 12

There are various forms of sruks, like juhū, used for offering oblations supported by 'upabhrt and along with dhruva,[70] pracaranī used in offering oblations in soma-yāga and agnihotra-havana[71] used in agnihotra

It is prescribed that juhū is made of parna *(Butca frondosa)*, wood, upabhrt of aśvattha *(Ficus religiosa)*, dhruva of Vikankaṭa *(Fla courtia sapida)* pracaranī of palaśa and agnihotra -havanī in Vikankata According to Āpastamba sruk is to be made of śaṃī wood *(Prosopis spicigera)*, or alternately in gold [72] Three types of Sruk are given in the figure - 12

Sruva is a dipping spoon, used for scooping liquids in rituals like Gārhapatya, Anvāhārya-pacana, Darśa-paurnamāsa and Agnihotra It is an aratnī (24 angulas) in length and the bowl (puskara) is a small one, its diameter being not more than the top of the thumb of the sacrificer's hand It is made of khadira wood *(Acacia catechu)* or of parna wood *(Butca frondosa)*[73] In the pravargya ritual, it is prescribed to be made of udumbara *(Ficus glomerata)* In magical rites it may be made in gold, silver or copper

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69 समाबिल दारयमाणो जुह्वा मध्यर्दश उपभृति भूमौ प्रतिष्ठिताया ध्रुवाया ।। चतुर्जुह्वामष्टावुपभृति चतुर्ध्रुवायाम् ।
– ĀŚS 11 7 3-4

70 स्फ्यमग्निहोत्रहवणी स्रुव जुहूमुपभृत ध्रुवम् । – ĀŚS XI 2 16
श्रीनिष्टवार्धमौपभृतस्य जुह्वामानीयोत्तराविष्ट्वा प्रत्याक्रम्य शेषेण ध्रुवामाभिधार्यानुपूर्वं हवीष्यभिधारयत्युपभृत-मन्ततः । – ĀŚS II 17 P 94

71 शमी मय्यो सुवर्णमय्यो वा स्तुचो भवति । – ĀŚS II 3 7

72 खदिरः स्रुवः पर्णमयी जुहूराश्वथ्युपभृद्वैकङ्कती ध्रुवा । – ĀŚS 1 15 10
एतेषा वा वृक्षणामेकस्य स्रुचः कारयत् । – 15 11
बाहुमात्र्योऽरत्निमात्र्यो वाग्राग्रास्त्वक्ताबिला हसमुखः । – ĀŚS 1 15 12

73 पात्र्यामुपस्तीयर्दिः प्रथमस्तुर्भुवनस्य गोपाः शृत उत्स्वानि मतीनामित्यपर्यावर्तयन्पुरोडाश मुद्वास्य ।
– ĀŚS II 10 6

Indological Truths

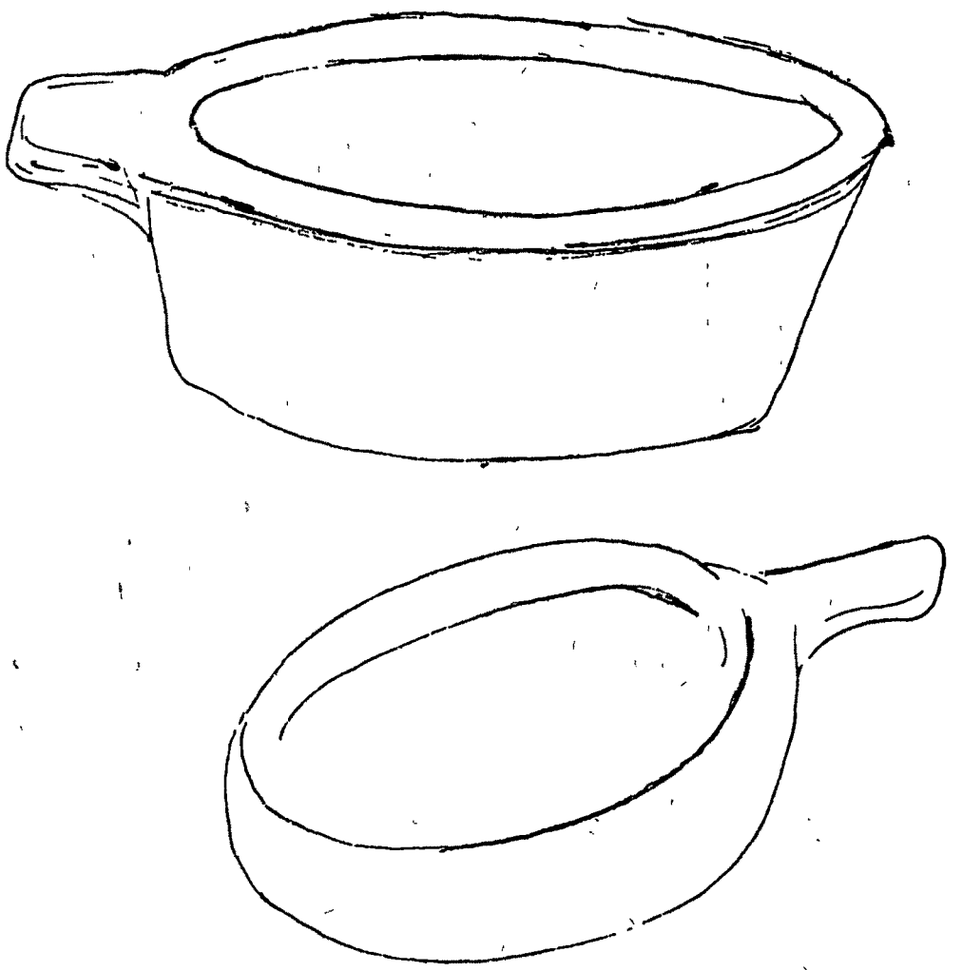
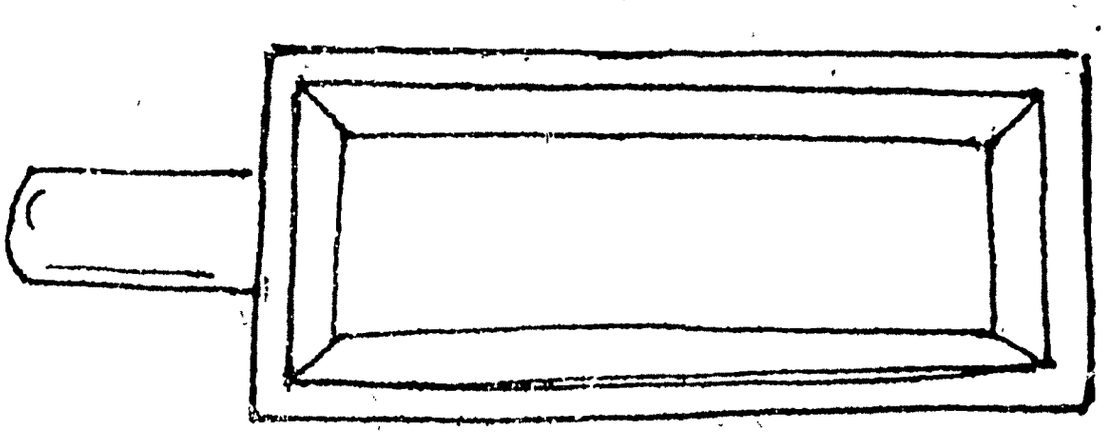


Fig 14



PISHṬODVAPANI Fig 15

Indological Truths

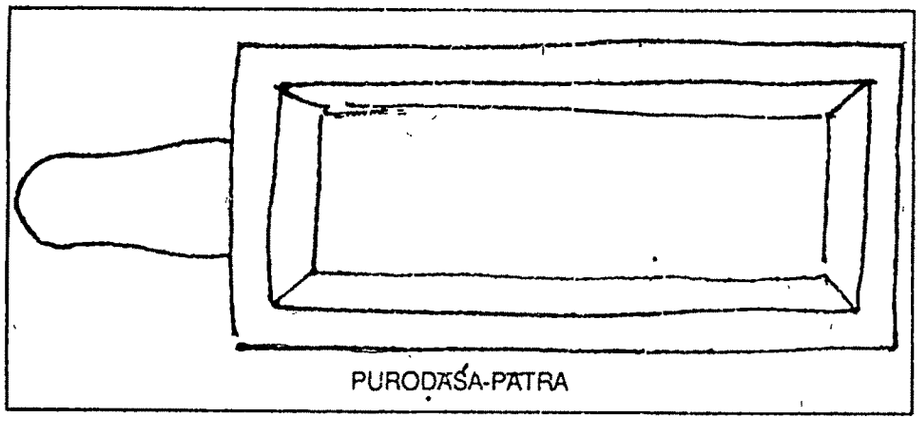


Fig 16

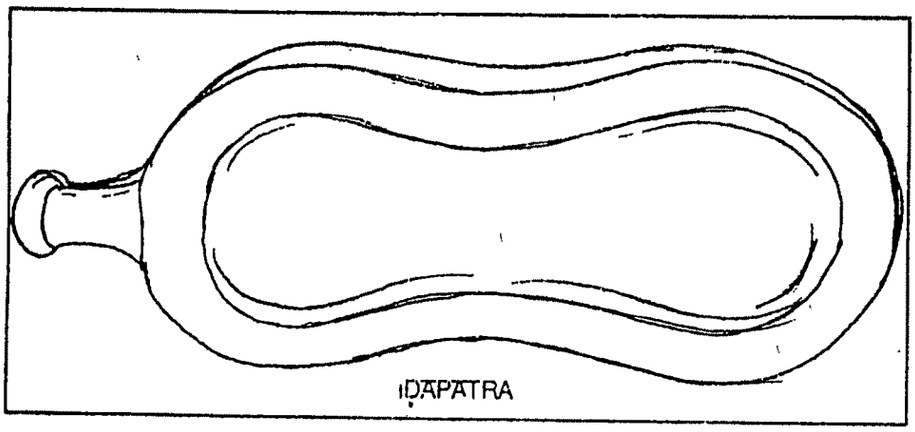
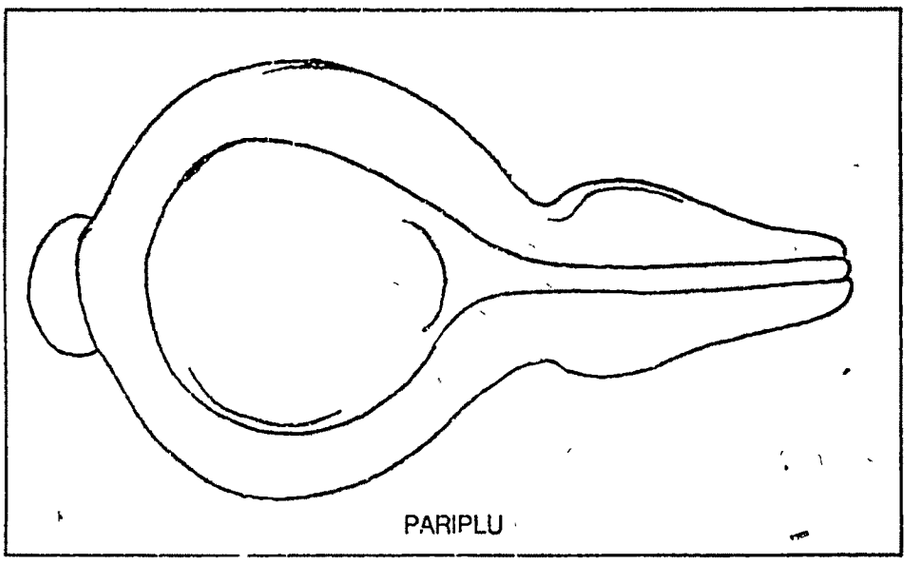


Fig 16



Indological Truths

The two varieties of 'Sruva' is shown in the figure - 13

Pranīta:

Pranīta is a wooden vessel in which consecrated water is stored, while making puroḍāśa cakes for oblations, water from this vessel is mixed with the flour The vessel is also meant to store soma-juice It is made of nyagrodha *(Ficus indica)* rauhītaka *(Andersonia)* Vārana *(Crataeva rox burghī)* or Vikankaṭa *(Flacourtea sapida)* wood The vessel is square in shape, eight angulas long and broad and four angulas height, the bowl is three angulas deep, and holds about half a prastha of water (See fig - 14)

Piṣṭa-pātra:

The flour for making purodāśa cakes for oblation is stored[74] in pista-pātra, a container made of Vārana wood *(Cataeva voxburghii)* or in clay It is also called pist odvāpanī and according to some, it must be 20 angulas long and broad with a circular depression to hold the dough, others say that its size must be 24 angulas long and broad (aratni-mātra) More commonly it is rectangular in shape According to Sāyana, however, it can be of any shape but only made of clay If it is a wooden vessel,[75] it has a handle as shown in the figure - 15 A vessel similar in shape, but along with corners rounded off and narrow in the middle is idā-pātra,[76] one aratni (24 angulas) as shown in the fig It is also made of Vārana wood The vessel to keep the baked purodāśa cakes is square in shape, prādeśa (viz 12 angulas) long and broad, the depth of the depression in middle is six angulas Its shape is as shown in the figure - 16

Prokṣaṇi:

This is a vessel made out of Vārana wood[77] *(Crataeva voxburghī)* or vikankata *(Flacourtia sapida)* and with a long handle as in the figure - 17 The vessel is 12 angulas long and has a depression, shaped like a lotus leaf (padma-patrākrti) or lotus

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74 विंशति अङ्गुलमात्र विस्तारयत सुवृत्तः । – ĀŚS IV 7 8 464

75 आकारनियमरहित मृण्मय्येव । – Aita Brā 39, 3

76 इडापात्र उपस्तीर्य सर्वेभ्यो हविर्भ्य इडा समवद्यति चतुरवत्ता पञ्चावत्ता वा । – ĀŚS II 1 6

77 वारणान्प्रोक्षिणी भवन्ति । – ĀŚS II 16 14

Indological Truths

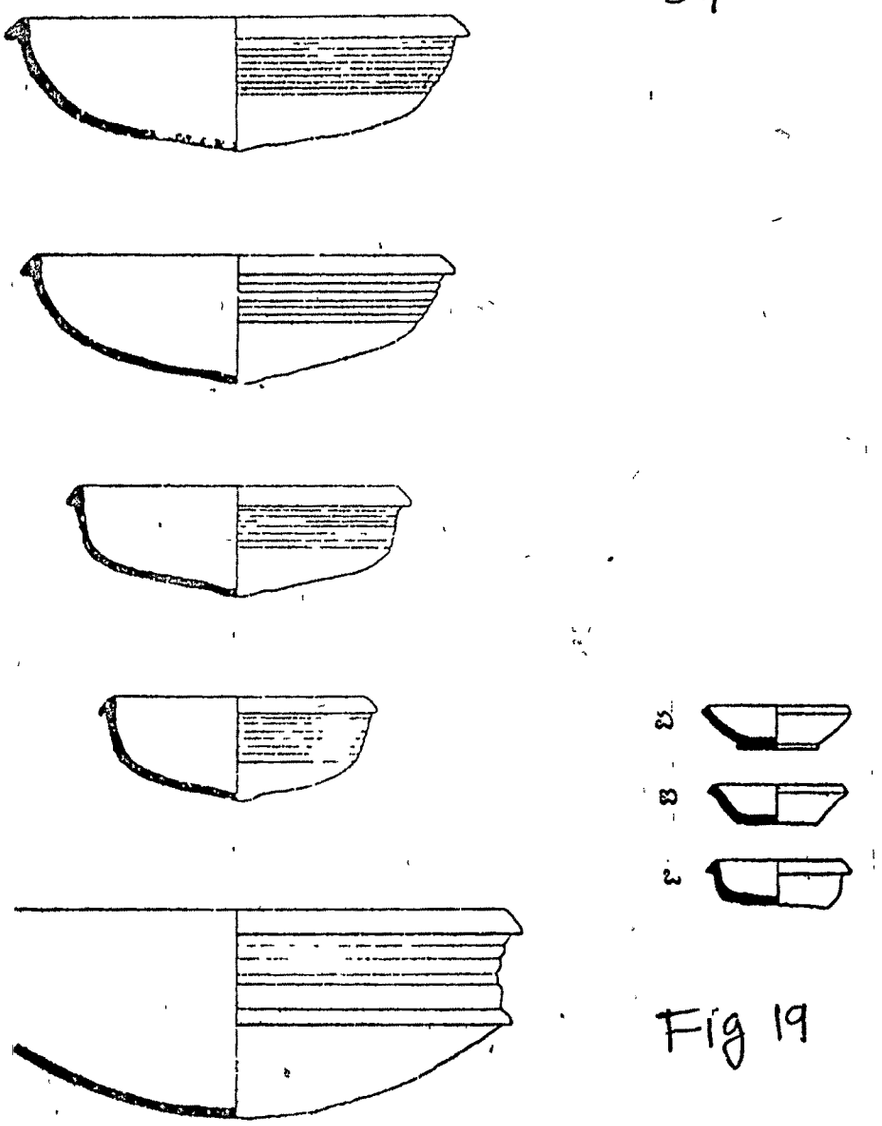


Fig 19

Stalis (Various types)

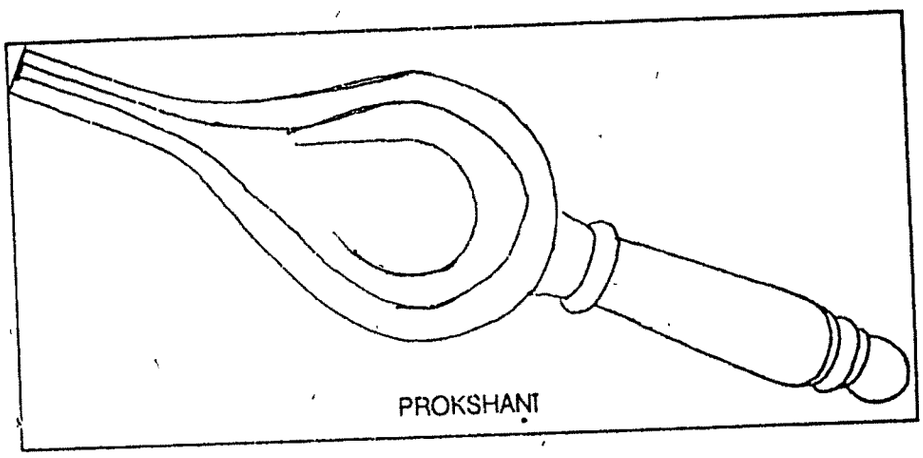
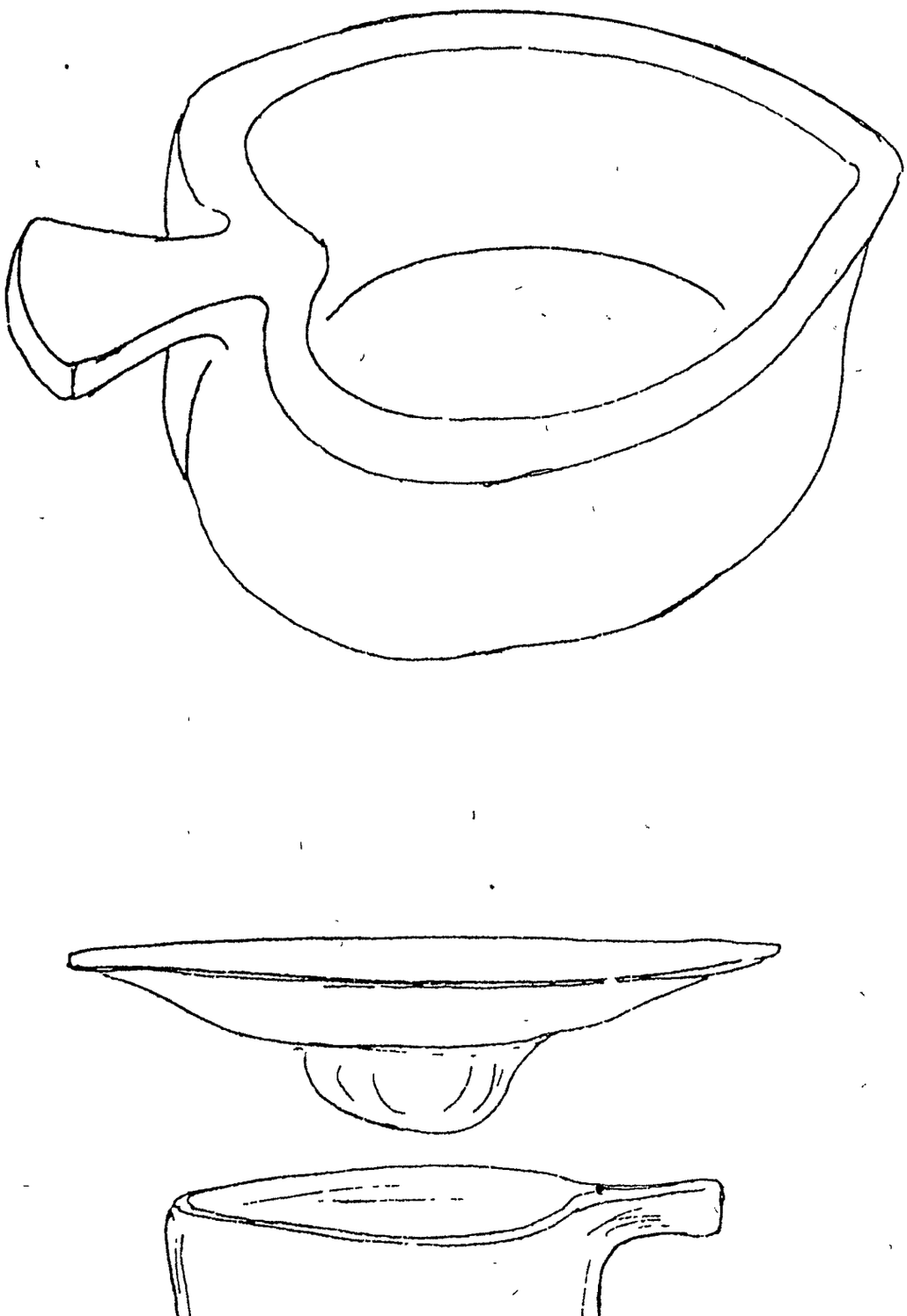


Fig 17

Indological Truths



DRONA-KALAŚA AND DAŚĀPAVITRA

Fig 18

Indological Truths

bud (Kamalamukulākrtı) It holds the holy water used for consecratıng (prokshana -ceremonıal sprıng)[78] the artıcles and the oblatıons wıth water sprınkled wıth the darbha tıps *(Saccharum cylındrıcum)* to make the water holy [79]

Droṇakalaśa:

It ıs a large vessel made of strong and hard wood lıke Vārana or vıkankaṭa[80] foı storıng thc soma-juıcc [81] It ıs a trough (*drona*), squarc or cırcular ın shapc wıth a handle (*danda-yuta*) as shown ın the figure - 18 It may alternately be shaped lıke a boat (*naukākāra*) Parıplu (or *udancana*), a small wooden bowl (*laghu-pātra*) shaped lıke sruk (but wıthout a handle) ıs employed to take soma juıce out of dronakalaśa for purposes of oblatıon[82] and the soma-juıce that ıs stored ın drona-kalaśa ıs already straıned and kept ready for offerıng and drınkıng

Sthālī and Grahas:

There are several kınds of earthern bowls or dıshes (sthālī) for varıous purposes Agnıhotrasthālī whıch ıs for the fresh mılk got from the cow (Go-dohana) ıs prescrıbed to be made by the hand of the sacrıfıcer or one of the offıcıatıng prıests [83] Ājya-sthālī[84] ıs for storıng the clarıfıed butter requıred for oblatıons and usually ıt ıs constructed from the earth ıtself [85] Lıkewıse, there are prsad-ājya-sthālī,[86]

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78 उपविल चमस पूरयित्वा प्रोक्षणीवदुत्पूयाभिमन्त्र्य ब्रह्मन्तपः प्रणेष्यति यजमान वाचं यच्छेति सप्रेष्यति ।
– ĀŚS 16 5

79 युनक्त्वित्युत्तरेणाहवनीयमसस्पृष्टा दर्भेषु सादयति । – ĀŚS 1 16 10

80 तेषां यान्यनादिष्टवृक्षाणि वैकङ्कतानि स्युः । – ĀŚS XII 1 4

81 द्रोणकलशादुपस्तीर्य पूतभृत उन्नीय द्रोणकलशादभिधारयति । – ĀŚS XII 21 15

82 द्रोणकलशाद्गृहान्त इति सर्वग्रहाणा स्कन्नानामुदस्ताना च विज्ञायते । – ĀŚS XIV 27 5

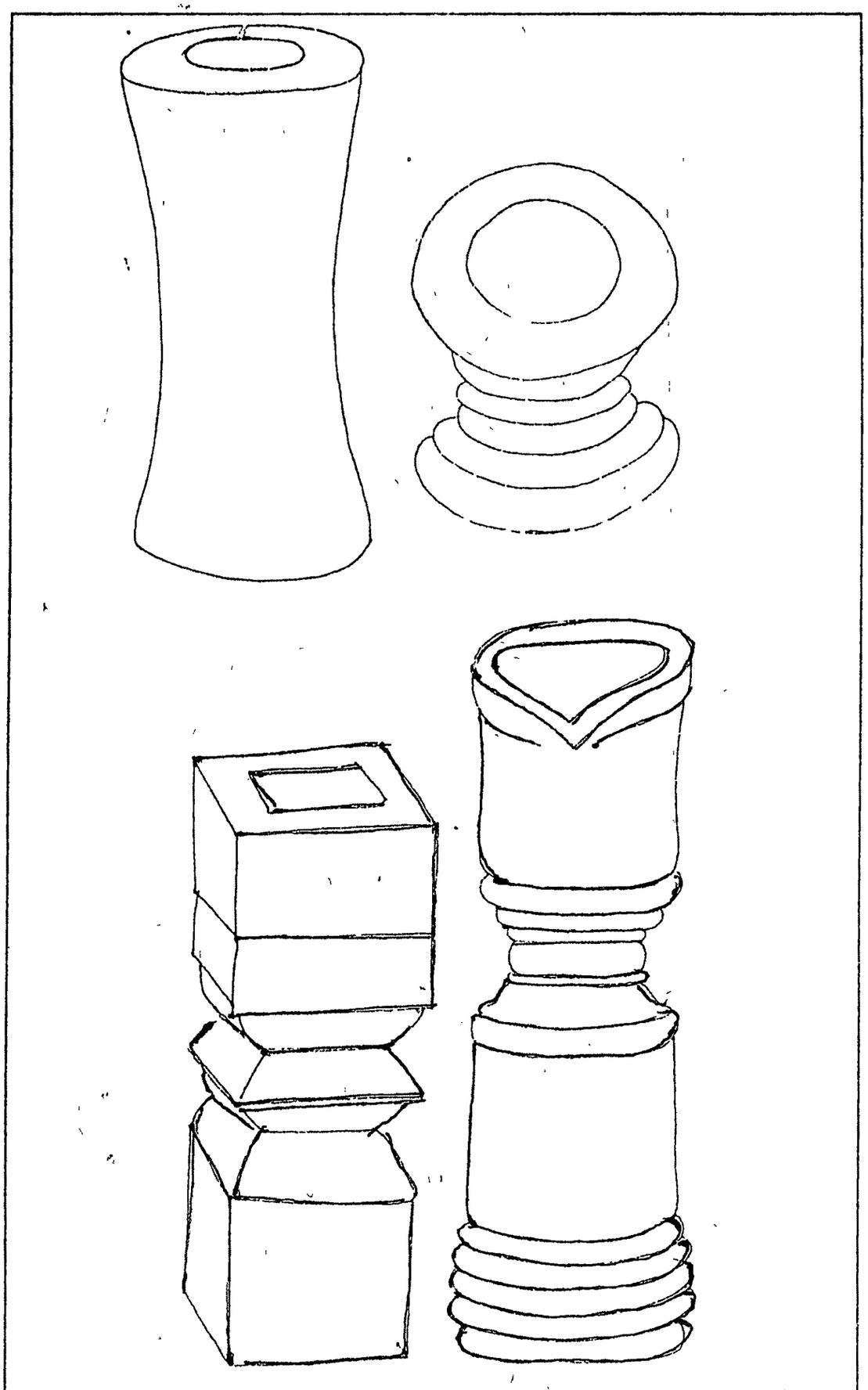
83 (ı) आचार्य कृमी भवति ऊर्ध्वकपाला असुर्यं वा एतत्पात्र । – मैत्रा स 1 8 3
(ıı) यत् कुलालकृत चक्रवृत्तम् ।
प्रसृताकृतिरार्यकृताग्नि होत्र स्थाली ऊर्ध्वकपालाऽचक्रवर्ताभवति । – ĀŚS VI 3 7
(ııı) स्थाल्या दुहति । – मैत्र स 1 8 3
(ıv) अग्निहोत्र स्थाल्या दोग्धि ।

84 यदि यच्चन्त पश्चात्स्यद्वेदात्तृणमपादाय जुह्वामग्रमज्ज्यासुवे मध्यमुपभृतिवाज्यस्थाल्या मूलम् । *ĀŚS III 14 7*

85 मृण्मयी प्रस्थपूर्णा आज्यस्थाली । – वैखा श्रौ सू 11 9

86 ĀSS VII 8 7 पृषदाज्य यस्या क्रियते सा च पृषदाज्यस्थाली एव सत्या । – श्रौ सू 4

Indological Truths



GRAHAS

Fig 19*

Indological Truths

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caru-sthālī,[87] dhruva-sthālī,[88] āgrayana-sthālī,[89] anvāhārya-sthālī[90]. ādıthya-sthālī,[912] ukthya-sthālī[92] etc The structure of sthālī ıs as shown ın the figure - 19

Grahass or mortar-like cups:

(A 14181)

Nıne mortar lıke cups, a span hıgh but narrow ın the mıddle called 'grahas' (also pātra) are used [93] 'Upāmśu graha, soma graha,[94] antaryāma graha, aındra-vāyava graha, maıtrā-varuna graha, aśvına graha, śukra graha; manthı graha, ukthya graha and ādıtya graha Dadhī, aṃśu and adābhya grahas are four-cornered Whıle explaınıng the Agnıṣṭoma soma sacrıfice Āpastamba Śrautasūtra gıves the placement of these cups as follows

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Wıth agnırdevatā [95] he places the Upāmśu cup on the rıght shoulder (on the south-east corner of the Khara) wıth Soma devatā . , the Antaryāma-cup to the north (of the Upāmśu-cup) wıth brhannāsı the Upāmśusavana (the pressıng stone) wıth ıts face to the south between these two and touchıng those cups to the west of ıts (Upāmśusavana) the cups ıntended for dual deıtıes ın a lıne from the east to the west -wıth 'Indro devatā ' a cup wıth a garland (ınscrıbed) round ıt for 'Indra-vāyuh ' a cup wıth a mark of the protuberance on the neck of a goat for 'Mıtra-Varunaḥ ' a two-edged cup for Aśvınau to the west of these ın straıght lıne, wıth the cups for

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87 BŚS V 1 2 and ĀŚS I 7-5 चरू श्रपणार्थ स्थाली । आ श्रौ सू 2 6

88 तैत्तिरी ब्रा I 4 1

89 तै ब्रा I 4 1.

90 आ श्रौ सू I 15-9, द्रोणार्ध तण्डुला वान्वाहार्य । वैखा श्रौ सू 11 9 स्थाली कुम्भः । ऐ ब्र 1 5 6

91 तै ब्रा 1 4 1

92 Sanv. 1 4.1

93 प्रादेशमात्राण्यूर्ध्वसानून्युपरिष्टादासेचनवन्ति मध्ये सनतानि । – ĀŚS XII 1 4

94 उत्तरेऽसे दधिग्रहपात्रमौदुम्बर चतुःस्रक्ति । – Same XII 2 1

95 अग्निर्देवतेति दक्षिणेऽसं उपाशुपात्रम् ॥ २ ॥
सोमो देवतेत्युत्तरमन्तर्यामस्य ॥ ८ ॥ बृहभसीति ते उत्तरेण ग्रावाणमुपाशुसवन दक्षिणामुख सस्पृष्ट पात्राभ्याम् ॥ तमपरेण प्रत्यञ्चि द्विदेवत्यपात्राणि ॥ इन्द्रो देवतेति परिस्रगैन्द्रवायवस्य बृहस्पतिर्देवतेत्यजगाव मैत्रावरुणस्य । अश्विनौ देवतेति द्विस्रवत्यश्विनस्य ॥ तान्यपरेण प्रबाहुकृशुकामन्थिनोः पात्रे । सूर्यो देवतेति दक्षिण वैल्व शुक्रस्य ।
– ĀŚS XII 1 7-12

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Sukra and Manthin with 'Sūryo devata ' the cup made of Bilva wood for Śukra to the south Ukthya cup on the north of Ukthya pot "

There are several other articles used in a sacrificial context, each of which 'has not only a functional aspect but mystical significance also, like arani sticks,[96] āsandi-seats,[97] ladle-plank (kūrca), soma-pressing boards (abhisavana-phalaka)[98], the sacrificial post (Yūpa) darbha cutting aside, the hammers (Vighana-mudgara)[99] deer-hide fans (dhavitra)[100], rice-stirring sticks (mekṣana[101] also used for offering oblation to the manes) fire-stoking sticks (upaveśa)[102], milk pails (pinvāna) and so on

Yūpa:

In sacrifices where animals are involved, an important article is Yūpa or sacrificial post It is a wooden pillar carved of Khadira wood *(Acacia catechu)*, bilva wood *(Aegle marmelos)*, palāśa *(Butca frondosa)* aśvattha wood *(Ficus religiosa)* udumbara wood *(Ficus glomerata)* or Kramuka wood *(Areca faubel)* The height of the Yūpa varies according to the yajña variety 17 aratnis (or 24 angulas) in Vājapeya, 9 to 21 aratnis in agniṣṭoma, nine aratnis in paśu-bandha [103] The base of the Yūpa is required to be one aratni in height and is buried underground This part may also be equipped with an iron ring called Yūpa-Kaṭaka The Yūpa is either cylindrical in shape or four-sided, alternately it may be eight-cornered [104] The Yūpa is so called

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96 अरणी आहरति अश्वन्थी शमीगर्भमिप्यशमीगर्भी वा चतुराङ्गुलमुत्सेधा द्वादशाङ्गुल विस्तीर्णा षोडशाङ्गुलमायताम् । – BŚ S 2 6

97 आसन्दी । ĀŚS X 29 7, 31 7, XII 19 6, XVI 15 8, 16 1

98 अभिषव । ĀŚS XII 25 17, XIII 1 1, 10,11

99 तिधान Same XXII 13 12, 28 6

100 धवित्र, – ĀŚS XV 5 12, 8 5, 15, 15,1

101 मेक्षज – ĀŚS 1 7 5, X 21 18, XIII 13 12

102 उपवेश Same 1.6 7 , II 5 12 1, 15 9 22 2

103 यूप करोति सक्षीर स्थूल मूले बालाग्र अष्टश्रीः करोति पलाश पुष्टिकामस्य वैल्व ब्रह्मवर्धसकामस्य । औदुम्बर अन्नाद्यकामस्य । खादिरं बलकामस्य । वैभीतक राजवृक्षौ ब्रातृव्यवतः । पञ्चदश सप्तदशैकविंशत्यरत्नि वा । – बौ श्रौ सू 4-1 & 25 शा ब्र 5 4 1-12, आ श्रौ सू 7 16, का श्रौ सू 6 1, 19-21

104 पिशाखो यूपो भवतीति । ऊर्ध्वरशनाकालात् द्वेशाखे चतुरश्रो चतुरश्र चषाले स्यात् । अथ तरोडष्टाश्रिर्यूपः स्यादिति बोधायनः । शाखैवेय चषाला ध्यादथेतरोऽष्टाश्रिर्यूपः स्यादिति शालिकिः । – बौ श्रौ सू 20 25

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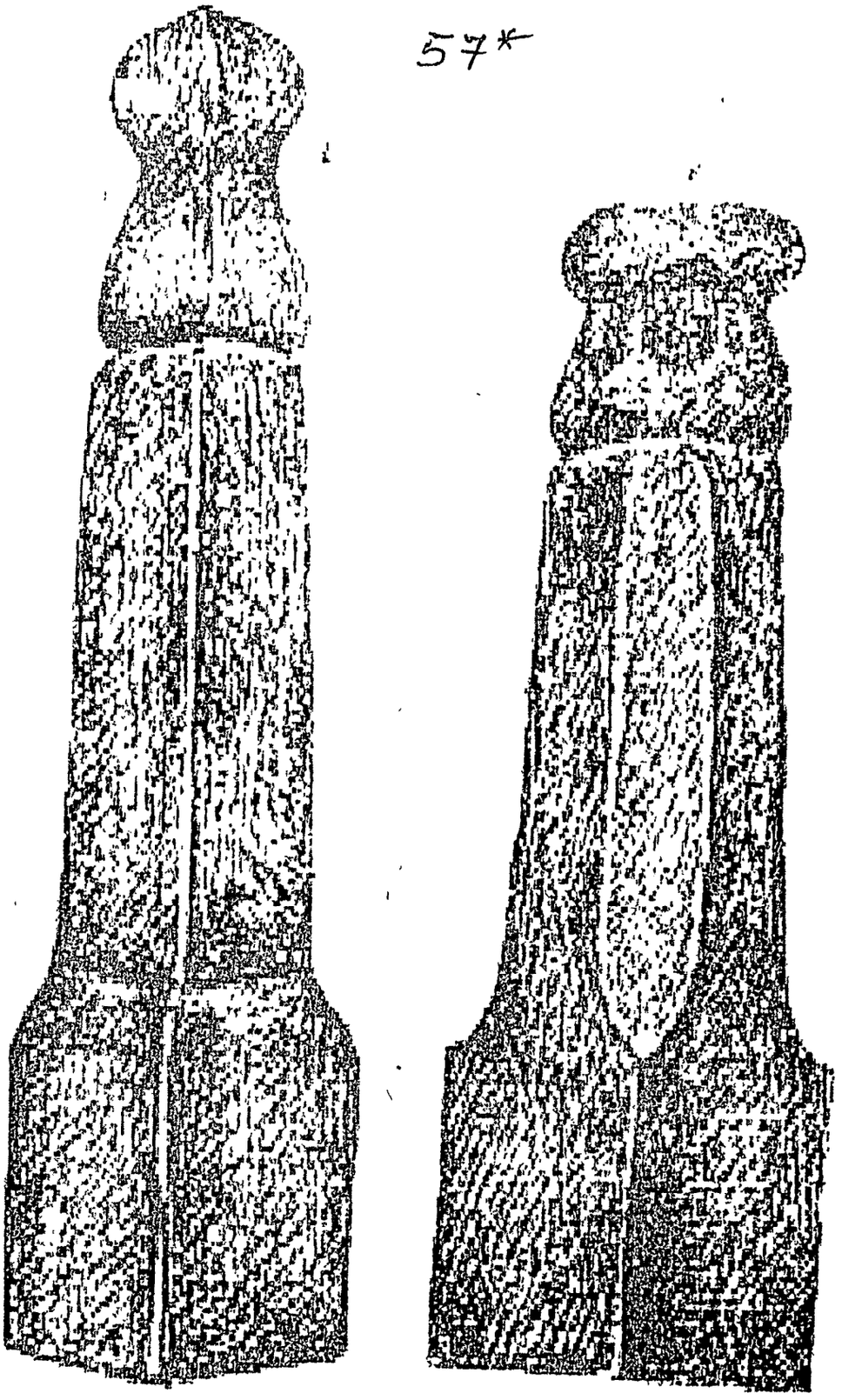
57*



Yupa & Caśala

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because the sacrificial animal is fastened to it One top of the Yūpa is a detachable mount made of wood or prepared out of wheat flour It is called 'chasāla' [105] The wood selected for the construction of Yūpa have some conditions Not only the wood mentioned above varieties, but also the wood should be without any defects It should have several branches and its branches are to be upward without having hole in side [106]

Wood that brought from the forest fixed at the eastern-region of the Uttaravedi After it is shaped like Yūpa, consequently involve prescribed vedic chanting 'Āśvayūpa' mentioned in Mahabhāsya of Patañjali[107]. To tie up animals in sacrificial place (Yajña-śāla), 21 sacrificial posts (Yūpa) have been fixed Each post to be one aratni The Yūpa and its parts are as in figure - 20

The Āpastambaśrautasūtra (VII 1 10)[108] explains Yūpa in this way "In the case of an animal sacrifice forming a part of a soma sacrifice having recited a verse connected with Visnu, he should go towards the tree to be cut for preparing the sacrificial post

"The Adhvaryu[109] takes the spoon and the ghee semang (offer this libation),

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105 चषालो यूपाग्रे प्रति मुच्यमानः कटकः । – तै सं 1 3 6

106 व्यावृत्तः कुष्ठिः कुब्जः शोले दग्धः शुष्कः सुषिरो घणजग्धः इत्यप्रशस्ताः अथ प्रशस्ताः शुद्धावर्ता अनूपर्वसमाः । मूल अरत्नि सत्वज निखनेत् । – आ श्रौ सू 7 1 16

107 चषाल ये अश्वयूपाय तद्धधाति । – पा मा भा 1 4 9, P 136

108 त्रैरत्नीवैवा चतुररत्निर्वा पालाशो निरूढपशुबन्धयूपः । – आ श्रौ, सू 2-2-7

109 वैष्णवीमृचमनूच्याच्छेतयः ॥ २० ॥ जुहुयाद्वा ॥ २२ ॥ यूपसकाशे वाग्निं मथित्वा तस्मिञ्जुहुयात् ॥ १ २) ॥ स्रुवमाज्यशेष चाध्वर्युरादत्ते । तक्षा शस्त्रम् ॥ २३ ॥ यत्र यूपस्तद्यन्ति ॥ २४ ॥ यूप्या वृक्षाः पलाशखादिरबिल्वरौहीतकाः ॥ २५ ॥ पालाश तैजस्कामो यज्ञकामो वा । खदिर स्वर्गकामो वीर्यकामो वा । बैल्वमन्नाद्यकामो वा ब्रह्मवर्चसकामो वा । रौहीतक प्रजाकामश्चक्षुष्कामो वा ॥ २६ ॥ समे जातमशाखज बहुपर्णशाखमप्रति शुष्काग्रमसुषिरमव्यावृत्त मधूर्णमृजुमूर्ध्वशकलमग्र ईषदुपवनत प्रागुदक् प्रत्यग्वौपनतम् ॥ २७ ॥ य कामयेताप्रतिष्ठितः स्यादित्युक्तम् ॥ २८ ॥ अतिक्रम्य यूप्यान्य जोषयते तमभिमन्त्रयते ॥ २९ ॥ अत्यन्यानगामिति । अथैनमुपस्पृशति त त्वा जुषे वैष्णव देवयज्याया इति ॥ २ ॥ देवस्त्वा सविता मध्वानकत्विति स्रुवेण सर्वतो मूल पर्यणक्ति । V ॥ २-३ ॥ ओषधे त्रायस्वैनमित्यूर्ध्वाग्र दर्भमन्नर्धाय स्वधिते मैन हिंसीरिति स्वधितिना प्रहरति ॥ ४ ॥ त्र्यरत्निश्चतुररत्निर्वा पालाशो निरूढपशुबन्धस्यातोऽन्यः सौम्यस्याध्वरस्येति वाजसनेकम् ॥ २ ७ ॥ मूलतोऽतष्टमुपरम् ॥ V ॥ ३ १ ॥ अष्टाश्रिरनुपूर्वोऽग्रतोऽणीयान्त्रज्ञाताग्रिष्ठाश्रिरस्थूलोऽनणुः ॥ २ ॥ अवतक्षणाना स्वरूरधमन्थनश्च शकलः ॥ ३ ॥ अग्राद्यषाल पृथमात्रमध्याश्रि मध्ये सनतम् ॥ ४ ॥ य कामयेतान्योऽस्य लोकन्योरोहेदिति तस्यान्यवृक्षस्य स्वरुचषाले कुर्यात् ॥ ५ ॥ यावदुत्तममङ्गुलिकाण्ड तावदूर्ध्वं चषालाद्यूपस्यातिरिक्त द्व्यङ्गुल त्र्यङ्गुल चतुरङ्गुल वा ॥ ६ ॥
– Ā Śr S Pp 287-294

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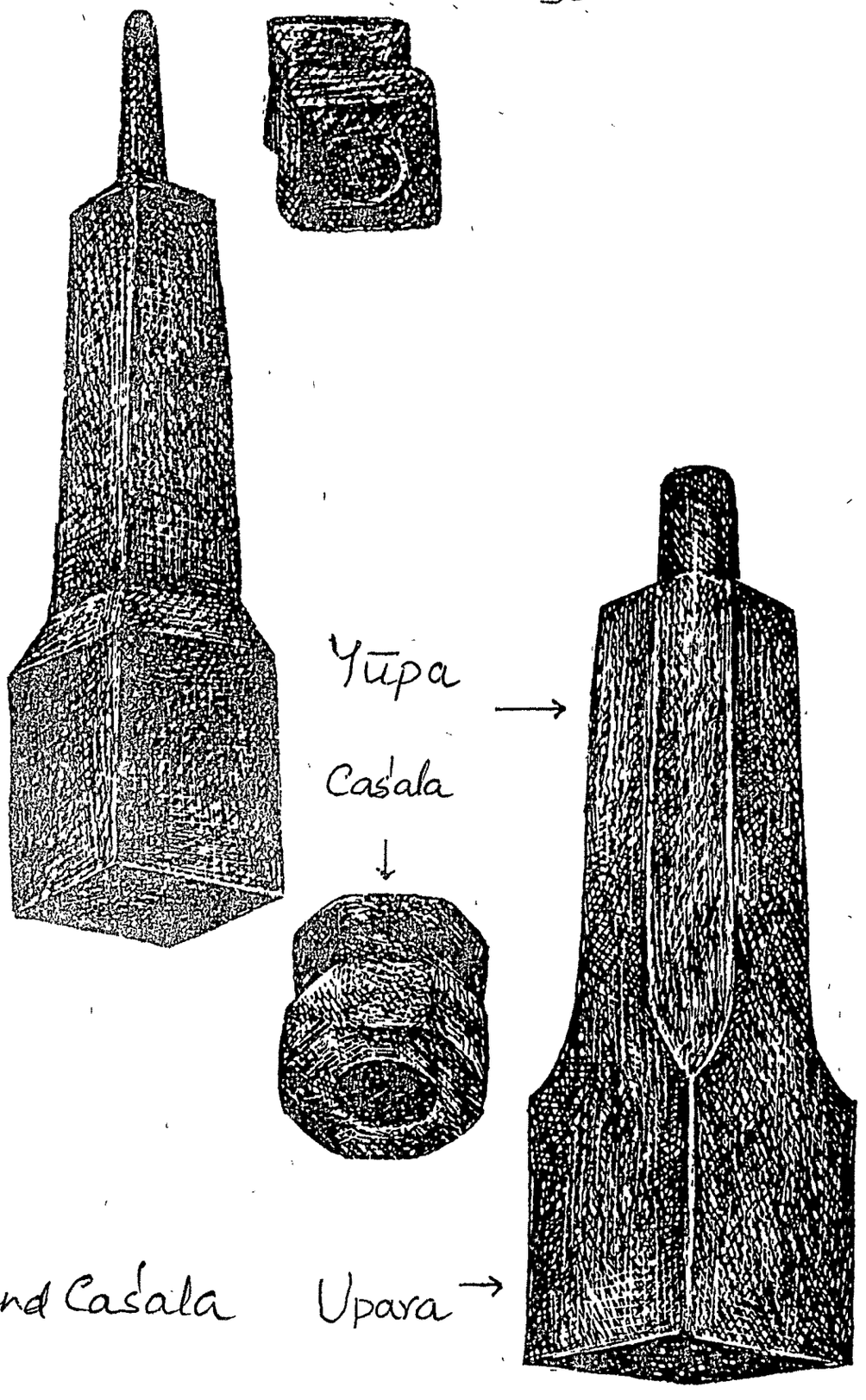

Yūpa and Caṣāla Upara →

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the carpenter takes the weapon (axe) (Then they) go towards the place where the sacrificial post is Palāśa *(Butea frondosa)*, Khadira *(Acacia catechu)* Bilva *(Aegle marmelos)* and Rauhītaka *(Andersonia rohitaka)* are the trees to be cut for preparing the sacrificial post A sacrificer, desirous of lustre of sacrifice (should prepare a post) of Palasa , desirous of heaven or desirous of power of Khadira , desirous of food and eatables or desirous of Brahman lustre of Bilva , desirous of progeny or desirous of eye. of Rohītaka He prepares the sacrificial post out of a tree which is born on an even place not born out of a branch (of another) possessing many leaves and branches, not with dry top, not hollow, not turned backward, not wavering, straight foreward with its branches going upwards, slightly bent at the top, and bent either towards the north-east or to the west Having gone beyond (at least three) trees suitable for the sacrificial post, head-dress the tree which he accepts Then the Adhvaryu touches it and he anoints by means of the spoon on all sides towards the root part With having kept a blade of Darbha grass with its point upwards, in between (the tree and the axe) he strikes (upon the tree)

The sacrificial post of the Nirūdha-paśubandha made of Pālāśa having three or four cubits length, the (sacrificial post) other than this is to be used for a soma-sacrifice this is the view of the Vājasaneyins Towards the root side there should be the Upara part chistelled The post should have eight sides Thinner (from the root part) towards the top, with the side which will stand facing the fire Well marked (in advance), neither (too) broad nor (too) thin Out of the chips that fall down a svaru and a piece which will serve for churning sticks to place upon (are to be made) Out of the top part of sacrificial post Casāla (cap) (should be prepared which should be) of the size of thirteen fingers in length (prtha) having eight sides, and narrowed in the middle As much as the last part of the finger should be kept additionally over the Casāla from the sacrificial post or it may be two fingers or three fingers or four fingers (in length)

Conclusion :

Thus units and instruments of Śulbasūtras are essential for the measurements

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of layout of vedis and citis, which utensils (or Yajñāyudhas) are required for performing the sacrificial rituals in a proper way The Śulbasūtrakāras and Śrauta Yajñakāras have developed the instruments in a very systematic way They are really genius to have wonderful methodology with a systematic use of the materials which are mentioned above

□

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Chapter - 4

Construction of "Yajña-Vedi" - Its mathematical and sacrificial importance

Introduction :

The Śrautasūtras contain a very detailed meticulously accurate and vivid description of the several sacrifices that were performed in ancient times These works were manuals compiled for the practical purpose of giving directions to those who are engaged in such sacrifices They are based on ancient Brāhmana texts which they quote at every step, many individual sūtras being couched in the very language of Brāhmanas [1] and on actual practice

Classification of Yajñas:

The *śrauta yajñas* are of two major kinds '*Havir-yajñas*' and '*soma-yajñas*' The oblations in '*havir-yajña*' are clarified butter (*ājya*) boiled preparations of rice, barley or wheat (caru), the faggots of selected trees (*samidha*) etc , whereas the oblation in the '*soma-yajñas*' is the '*soma*'-juice which is also drunk later by yajamāna and the rtviks Each of these two kinds has seven varieties separately The seven '*havir-yajñas*' are also called '*istis*', and they are '*agnyādheya*', '*agnihotra*', '*darśapūrṇa-māsa*', '*āgrayana*', '*cāturmāsyā*', '*dāksāyana*' and '*sautrāmani*' [2]

The *soma-yajñas* are *agnistoma, atyagnisṭoma, ukthya* (performed mostly by *Kshatriyas*), *sodaśin, vājapeya, atirātra* and *āptoryāma* In these sacrifices the *Agnistomas* is a model of all the *soma* sacrifices [3] The *agnisṭoma* is a one day

1 See Appendix B Ś S 6 7 (II 40)

2 According to Sāyana's Commentary on Aitareya Brāhmana (5 7) But Gautama Dharma sūtra (1 8 20) Gopatha Brāhmana (1 5 23) have different lists anvādhāya, agnihotra, paurnamāsi, amāvāsyā, cāturmāsya, nirūdhapaśubandha and navesti त्रीणि प्रधानानि- आग्नेयः उपांशुयाजः आज्यहविष्कः अग्नीषोमीयः पुरोडाश इति । तत्रेमानि क्रमेण अनुष्ठीयन्ते । Śukla Yaj Saṃ 2 18

3 Gau Śr Sū 8 2 Lat Śr 5 4 24

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(*aikāhika*) sacrifice and it is an integral part of the *Jyotiṣṭoma* So much so that, the two are of identical Jyotiṣṭoma is performed generally for five days Some other sacrifices which are well-known as- *aśva-medha, rāja-sūya, paunḍarīka, mahā-vrata, sarvato mukha, brhaspati-sava, abhijit and angirasa* are performed for more than five days

What is Vedi?

For the performance of these type of sacrifices certain specified area is needed where various altars are constructed A '*Vedi*' is a specified raised area on which the sacrifice is to be performed and on which persons performing the ceremony,[4] namely, the sacrificer, the *hotā*, the *adhvaryu*, the *rtvik* and others are to take their seats on this vedi It is a consecrated ground, where ritualistic cleaning, digging and other details of construction are gone through Some of the main Vedis include (1) the Mahavedi, (2) the Darśapūrnamāsavedi, (3) the Sautrāmanivedi, (4) the Paitrkivedi, (5) the Uttaravedi and (6) the Aśvamedhavedi [5] Each of these vedis are different in size and shape These type of Vedis are the platform for the sacred fires The construction of vedis involve geometrical measurements and architectural designs

The Plan of the Sacrificial ground :

The construction of sacrificial chamber is not done wherever required First, the place for worship and performance of various sacrificial rites is selected For example, the site satisfying the following specifications should be selected for performing the soma sacrifice The site for the soma sacrifice should have water on its eastern side The soil at this site should not be saline, it is not to be added to, it should not be fissured or barren The soil should be fertile, so that there is ample growth of vegitation and various kinds of plants are intermixed The ground should be sloped towards the north-east, so that the water would flow towards the *catvāla* as it is located near the north-east corner of the *Mahavedi* The ground should be

4 वेदिश्च सम्मार्जनोद्धननादिभिः संस्कारैः सस्कृता भूमिः । Yaj V Sam 9 20

5 Baudhāyana, Āpastamba, Kātyāyana Śrautasūtras have explained these Vedis in detail and I have explained this in page no

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even and should not be having much slope The location of the site should be such that in future no one could procure, a place for sacrifice on the nearby ground, particularly towards the east of the selected place [6] This shows that surrounding nature and atmosphere are also important in the performance of sacrificial ceremonies

Centre line of the Sacrificial Ground :

Once the site is selected for a sacrifice like Soma sacrifice, its central line (the *prsṭhyā*) should be fixed in the east-west direction As the sun does not rise and set at the true east and west directions, the method to determine these two directions by means of a *śanku* Thus the '*gārhapatya*' fire should be located in the centre of the fire-hall The centre of the *gārhapatya* fire should be the '*prsṭhya*'[7] the central east-west line of the fire hall

Thus before starting the sacrificial ceremonies, the sacrificial site is selected according to the condition of the sacrifice and planned systematically This shows how the ancient sages make these types of sacrifices in a very technical manner and with a systematic plan, like modern Civil Engineer's plan of a site The design of the sacrificial chamber and its measurements are also very systematic and scientific and that I am going to explain now

Construction of Sacrificial Chamber :

The sacrificial ground should be spacious enough for laying of the sacrificial hall, the '*mahāvedi*' and various pits, structures and elements required After drawing east-west line in a sacrificial ground the sacrificial hall, the '*prācīna-vamśa*' or '*prāgvamśa*'[8] is erected at the western end lying along, and symmetrically about the east-west line as shown in the figure The name is derived from the use of horizontal

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6 अयाते देवयजनकल्पः । स एतद्देवयजनकल्प जोषयते पुरस्तादुदकमनूषरमनुपहितमविसृवदार्यनिरिणमसुषिरम भङ्गुरमवल्मीकं बहुलौषधियत्रान्या अन्या ओषधयो व्यतिषक्ताः स्युः प्रागुदक्प्रवण यथा चात्वालसरिणीरापः स्युर्तातिप्रवणं यस्मादन्यत्पुरस्तात्समन्तिकं देवयजन न विन्देयुः ॥ B Ś S 25 5

7 गार्हपत्यस्यायतन मध्ये कुर्वन्ति । गार्हपत्यस्य मध्यादारभ्य पूर्वस्या दिशि ऋजुत्वेन नीयमान आहवनीयमध्यपर्यन्त सूत्र पृष्ठ्यासूत्रमित्युच्यते ॥ SPN 17-4

8 प्राचीनवशा दिक्ष्वतीकाशा दक्षिणतो वर्षीयसी ॥ तस्यै चतस्रो द्वारः कुर्वन्ति प्राची दक्षिणा प्रतीचीमुदीचीम् । B Ś S 6 1

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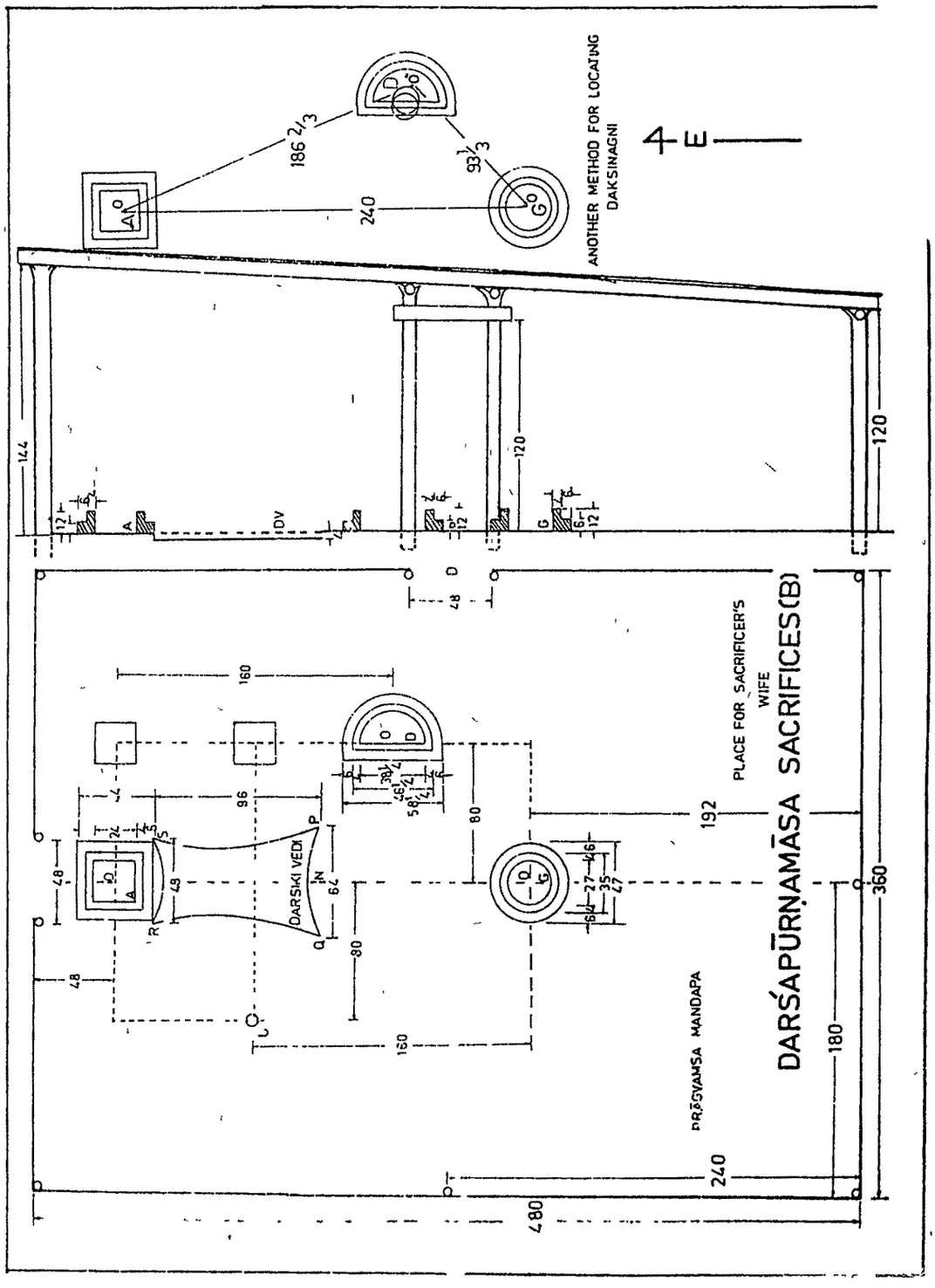
The Layout of Fire-Places and Altar (B) 63*



(Scale 0.4 mm = 1 Ang) Fig 21

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beams (*vaṃśa*) supported by four corner posts on which corner beams are fastened to serve as lintels of the eastern and western doors [9] In this hall besides the priests, the members of the family and friends of the person performing the sacrifice can assemble

Inside this sacrificial hall the tretāgnis, i e *Gārhapatya, Āhavanīya* and *Daksināgni* are located with perfect calculation The *gārhapatya* fire set up at the western end of the sacrificial chamber, the āhavanīya fire at the eastern, *daksināgni* on the southern side more towards west and the utkara on the northern side more towards the east of the fire-hall [10] The exact location and spatial magnitudes have been discussed later

In between the *āhavanīya* and the *gārhapatya* fire is placed on the fire altar, like '*dārśapaurnamāsika*' altar or such other altars as may be required The Utkara placed near the north-east side of the sacrificial chamber is a rubbish pit dug out in the ground East of the prācīna-vaṃsa and seperated by a narrow space the '*mahāvedi*' or the saumikivedi (the soma altar) placed symmetrically about the east-west (prasthya) line. This is a trapezium measuring 30 units on the western side and 36 units east-west and 24 on the eastern side along spine [11] The setting up of the '*mahāvedi*' is itself a wonderful drawing method step by step The narration of this plan of sacrificial chamber is like a map of civil engineer or designing of land-sketch with measurement as shown in the figure - 21

Location of the sacred fires:

The *gārhapatya, āhavanīya* and *daksināgni* are commonly known as *tretāgnis* or

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9 यस्यमण्डल विशेषस्योपरि वशाः प्रागग्राः भवन्ति स प्राचीनवश. प्राचीनवश करोति देवमनुष्यादिशो व्यभजन्त प्राची देवादक्षिणा पितरः प्रतीची मनुष्या उदीची रुद्रयत् प्राचीनवश करोति देव लोकमेव तद्यजमान उपावर्तते ॥ कृष्णयजुस्स का 6 1

10 प्राञ्चौ वेधसावुन्नयत्याहवनीयस्य परिगृहीत्यै । प्रतीची श्रोणी निरुहति गार्हपत्यस्य परिगृहीत्यै । पुरस्ताद्हीयसी पश्चात् प्रथीयसी मध्ये सनततरा भवतीत्येवमिव हि योषेति ॥ B Śr S 24 24

11 त्रिंशत् पदानि प्रक्रमा वा पञ्चात्तिरश्ची भवति । षट्त्रिंशत् प्राची चतुर्विंशति पुरस्तात् तिरश्चीति महावेदे विज्ञायते मानयोगस्तस्या व्याख्यातः । B Ś S 1 90

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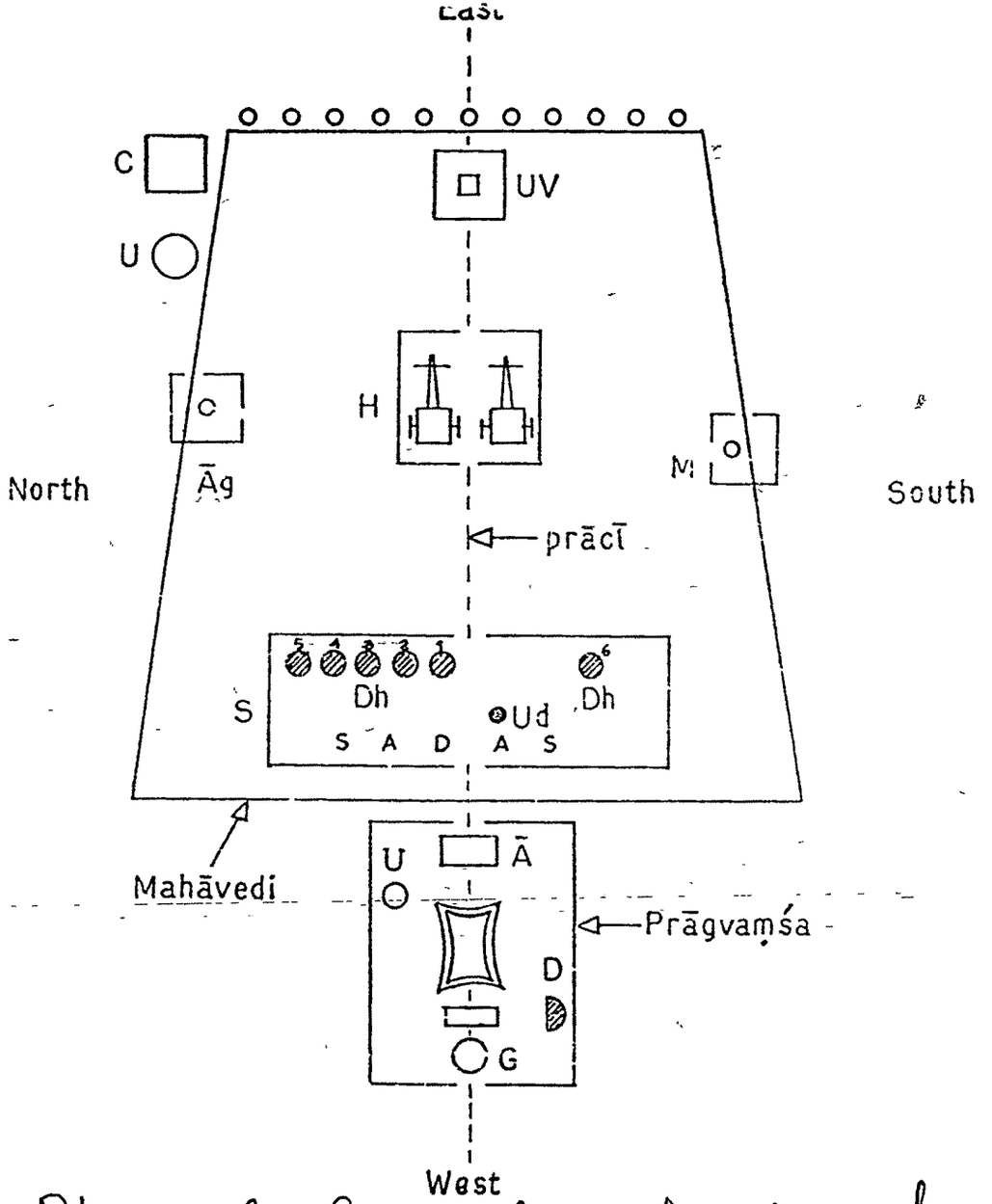

Fig 22. Plan of Sacrificial ground

sacred fires The *gārhapatya* is a house holder's fire received from his father and transmitted to his descendants It is a perpetual sacred fire from which other sacred fires are lighted This fire used by the priests for cooking oblations The *āhavanīya* is a consecrated fire taken from the householders' perpetual fire and is also used for cooking oblations The *daksināgni* also called *anvāhārya* pacana is used for cooking food [12]

Location of the *gārhapatya* fire-place should be fixed on the centre (i e on pracī), central east-west line of the fire-hall [13] Location of the *āhavanīya* and the *daksināgni* fire places should be fixed in relation to that of the *gārhapatya* fire towards the east of the *gārhapatya*, at a distance of 12 steps (*Vikramas)* the centre of the *āhavanīya* fire-place should be located The distance between centres of the *gārhapatya* and *āhavanīya* fire-places should be eight prakramas (240 angulas) if the sacrificer is a Brāhmana This distance should be 11 or 12 *prakramas* (330 and 360 angulas), if the sacrificer is a *Ksatriya* or a *Vaiśya* respectively It is mentioned in the śrauta *padārtha nirvacanam* and B Ś S that the *gārhapatya* fire-place should be circular, its diameter being 27 angulas Its area should be 376 angula The *āhavanīya* fire-place should be square shaped, the length of its being 24 angula Its area is same as of *gārhapatya* (i e 576 sq ang) The *daksināgni* should be semi-circular, its diameter being $38^1/_4$ angula Its area should be 576 sq ang [14] Its mathematical measurements are as shown in the figure - 22

After the location of three sacred fires and the area of the *mahāvedi* is thus marked out, the sadas tent is erected near the western base of the *mahāvedi* The tent is rectangular in area, the longer side lying south-north symmetrically about the

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12 Śat Br I- 1 2 23 देवागातु विदो गातु यज्ञाय विदन्तामनस्पतिना देवेन वाताद्यज्ञः प्रयुज्यतामिति जपित्वा मगाग्ने विहवेष्वास्त्वत्याहवनीयमुपसमिन्दधे । तिसृभिस्तिसृभिर्वा ।। ĀŚr S 1 1 3-5

13 मध्ये गार्हपत्यस्यायतनं कुर्वन्ति । पुरस्ताद् द्वादशासु विक्रमेष्वाहवनीयस्य । अपि वा चक्षुर्निमिते । दक्षिणतो विषुवत्यन्वाहार्यपचनस्य । BŚr S 2 12

14 दक्षिणाग्नेः ब्राह्मणः गार्हपत्यकुण्डवद् द्विमेखल शूर्पाकार दक्षिणाग्नि कुण्डमित्युच्यते ।। Ś P N 23-5, Same in BŚS 1 64-66

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east-west line and is provided with doors on the western and eastern side as shown in the figure This tent is reserved for the priests to sit and conduct various operations The place where Gods believed to have sat is called '*sadas*'[15] and so do these Brāhmans offering family now sit therein Clearly tent is divided by the *prācī* line in to two parts In the middle of it, a *Audumbari (Fiscus glamerata)* post is fixed at the ground in animal sacrifices (शाला मुखोयाच्छङ्कोरनुस्पन्द्य षद् प्राचः प्रक्रमान्प्रकामति दक्षिणा सप्तम् ॥ ... स औदुम्बर्येकान्तः॥ B Śr S 6 25)

Inside the sadas, six *dhisnya* hearths (Dh) are prepared These are subordinate or side altars, generally heap of earth covered with sand on each of which a fire is placed [16] There are actually eight *dhiṣnyas*, of which two, e g , the *agnīdhra* and the *mārjālīya* are placed outside the sadas Of these six hearths placed in the tent, five are placed on the northern part parallel to the east side and belong, in order from the south to the 1) *Hotr* 2) *Brāhmanācehāṃsī* 3) *Potr* 4) *Neṣṭr*, and 5) *Acchāvaka*[17] The *dhisnya* hearth belonging to the *Maitrā* Varuna or Praśāstr priest is placed on the southern half of the tent near the east side

The two other *dhisnya* hearths, e g the *agnīdhra* (*Āg*) and *mārjālīya*, (M) are placed in the middle part of the northern and southern side respectively of the *mahāvedi* as in the figure Both these hearths are set up under square sheds with four posts erected over them, open on the east side and the side facing the *havirdhāna* cart shed in the middle of the altar The *mārjālīya* is a heap of earth on which sacrificial vessels are cleansed and is last to be thrown up

Uparvas are sounding holes dug out in the ground near the *havirdhāna* They

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15 सर्वे देवा सदतीति सदसः । Śat Br III 5 3 5

16 सोक्षा एव सदो विमिमीते । यथा त्रीणि छदोषितिर्यञ्च्येव प्रवक्शो । यथा त्रीणि छदीव्यन्वन्येवमुदक्शो । तस्य त्रिश्रेणि गर्तान् खानयति ॥ B Ś S 6 26

17 त परिमण्डलं धिष्णिय करोति । अथैनरसिकताभिराभ्राशिन करोति ॥ अथान्तः सदश धिष्णियान्निवपति होतुः प्रथमम् ॥ दक्षिणतो मैत्रावरुणस्य ॥ उत्तरतो ब्राह्मणच्छसिनः । उत्तरतः पोतुः उत्तरतो नेष्टुः । उत्तरतो च्छ्रावकस्य । Bau Sr S 6 24
उत्तरेण हविर्धाने परित्यपूर्वावुपातीत्य मध्यमादौत्तरवेदिकाच्छङ्कोरनुस्पन्द्य त्रीन् प्रतीचः प्रारमान्प्रक्रामतः ॥ Bau Ś S 6 25

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should be four in number, their centres being located at four corners of a square, the side of which may be one 'aratni' long The Uttaravedi[18] (UV) is the raised near the eastern side of the mahāvedi, with the prācī line passing through in middle Uttaravedi is trapezium shaped or square shaped and should be contiguous to the north edge of the mahāvedi All these features are shown in the diagram - 23

The BŚr S [19] specifies the location and dimensions of the uttaravedi as The adhvaryu should measure 12 Ksudrapadas towards the west from the Yūpāvatīya peg along the cord indicating the prsthyā There he should fix a peg It is at the middle of the west side of the uttaravedi He should measure five ksudrapadas towards the south and five ksudrapadas towards the north, from the peg located at the middle of the west side There he should fix two pegs They denote two buttocks of the Uttaravedi He should measure four ksudrapadas towards the south and four ksudrapadas towards the north, from the yūpāvaṭīya peg There he should fix two pegs They denote two shoulders (the north-east corners) of the Uttaravedi Then he should measure the Uttaravedi with a diogonal measure and stretched out a cord round it on all sides The area of the Uttaravedi of trapezium shape as described in B Ś S is 10,800 sq ang Even if sides of the square shaped Uttaravedi are taken Ten *Ksudrapadas* long then its area will be 100X100 = 10,000 sq angulas Thus there are some differences in specification and also in dimensions of *Uttaravedi* as given in the B Ś S and the B Ś S (*Śulbasūtra*) where, it is a square pit of side 10 padas

The Cātvāla and the Utkara

The earth dug out from the cātvāla (C)[20] should be used for the preparation of

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18 यूपावटीयाच्छङ्कोङ्कोरर्धप्रक्रममवशिष्योत्तरवेदिं विमिमीते ॥ B Ś S 1 92

19 यूपावटीयच्छङ्कोरनुस्पन्द्य द्वादश प्रत्यञ्चि क्षुद्रपदानि प्रक्रामति । तच्छङ्कु निहन्ति । स मध्यमौत्तरवेदिकः शङ्कुः ॥ मध्यमादौत्तर वेदिकाच्चङ्कोः पञ्च दक्षिणा क्षुद्रपदानि प्रक्रामति पञ्चोदञ्चि । तच्छङ्कुनिहन्ति ते श्रोणि ॥ यूपावटीयाञ्छङ्कोश्चत्वारि दक्षिणा क्षुद्रपदानि प्रक्रामति चत्वार्युदञ्चि ॥ तच्छृकू निहन्ति ॥ ताव सौ ॥ अथैनामक्ष्णयामानेन प्रमाय समन्तॅस्पन्द्धयो परितनोति । पृष्ठयामातनोति ॥ B Śr S 6 22 दशपदोत्तरवेदिर्भवतीति सोमे विज्ञायते । मानयोगस्तस्या व्याख्यातः ॥ B Śu 1 98

20 अथ महावेद्या उत्तरादॅसीयाच्छङ्कोर्वेद्यन्तेन त्रीन् प्रतीचः प्रकमान्प्रकामति उदञ्च चतुर्थम् । तद्यात्वालस्यावृता चात्वाल परिलिखति । B Śr S 6 23

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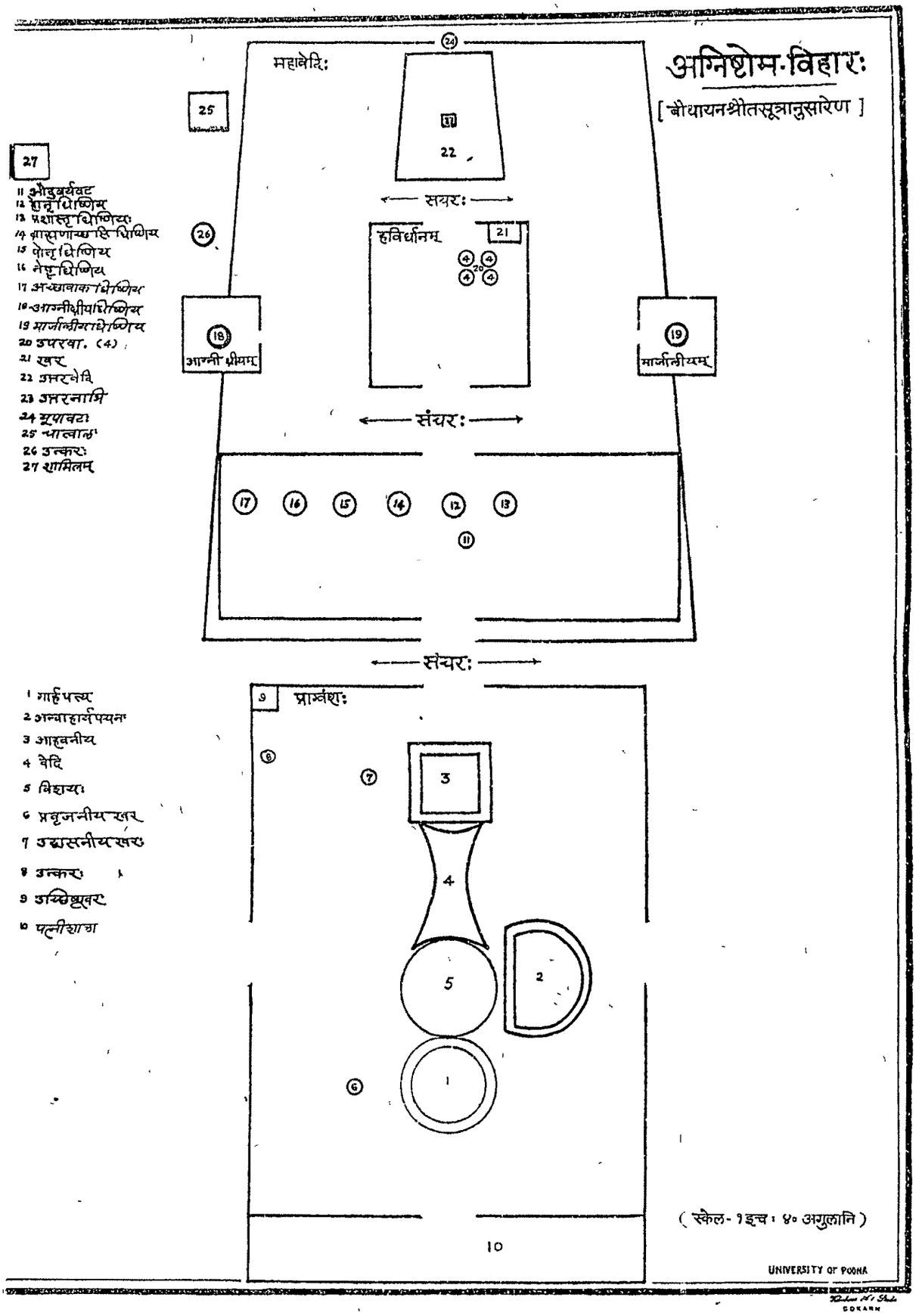

Fig 23

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the *Uttaravedi* The location of the cātvāla is given thus From the north shoulder (i e the north east corner) of the *Mahāvedi*, the adhvaryu should measure a distance of three *prakramas* (90 angulas) towards the west along the border of the Mahāvedi and then the one prakrama towards the north The point located gives the south-east corner of the *cātvāla* It should be square shaped the length of its sides being one *Śamyā* or more than one Śamyā Its depth depends upon the quantity of soil taken out to prepare the *Uttaravedi* The location of the Utkara, be obtained from the north-east corner of the *Mahāvedi*, the *adhvaryu* should measure the distance of 12 prakramas (360 angulas) towards the west along the northern border of the *Mahāvedi* and then one *prakrama* towards the north, that is the location of the *Utkara* The plan of sacrificial ground with different locations is as shown in the diagram - 23

Thus we find that the layout of the various sacrifices involve a systematic procedures of constructions and greatest care has to be taken in construction in fire-hall or sacrificial chamber

Sacrificial chamber according to Śulba-sūtras

Sacrificial chamber mentioned in Śulba-sūtras have clear special magnitudes Bodhayana mentions two types of sacrificial chambers (*prāgvaṃśa*) One is 16 *prakramas* long by 12 *prakramas* broad Another is 12 *prakramas* long by 10 prakramas broad In Mānava Śulba-sūtra the *prāgvaṃśa* occupies a square area of side 10 aratnis

B Ś S follows the tradition in the measurement of *mahāvedi* (i e of *Śatapatha Brāhmana*) explained in page number) It measures 30 *prakramas* on its western

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चत्वालो शम्यामात्रोऽपरिमितो वा । B S S 1 99

अथ महाविद्या उत्तरादँसीयाच्छङ्खोवेधन्तेन द्वादशप्रतीचः प्रक्रमान्प्रक्रामति उदञ्च त्रयोदशम् । तदाग्नीध्र उपसीदति । स उत्करस्य काको ॥ B Śr S 6 22

तत एकस्मिन्सदः ॥ B Ś S 1 92

तद् दशकम् ॥ 1 93

उदक् सप्तविंशत्यरत्नयः ॥ 1 94

अष्टादशोत्येकेषाम् ॥ 1 95

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SOMA SACRIFICE (B)

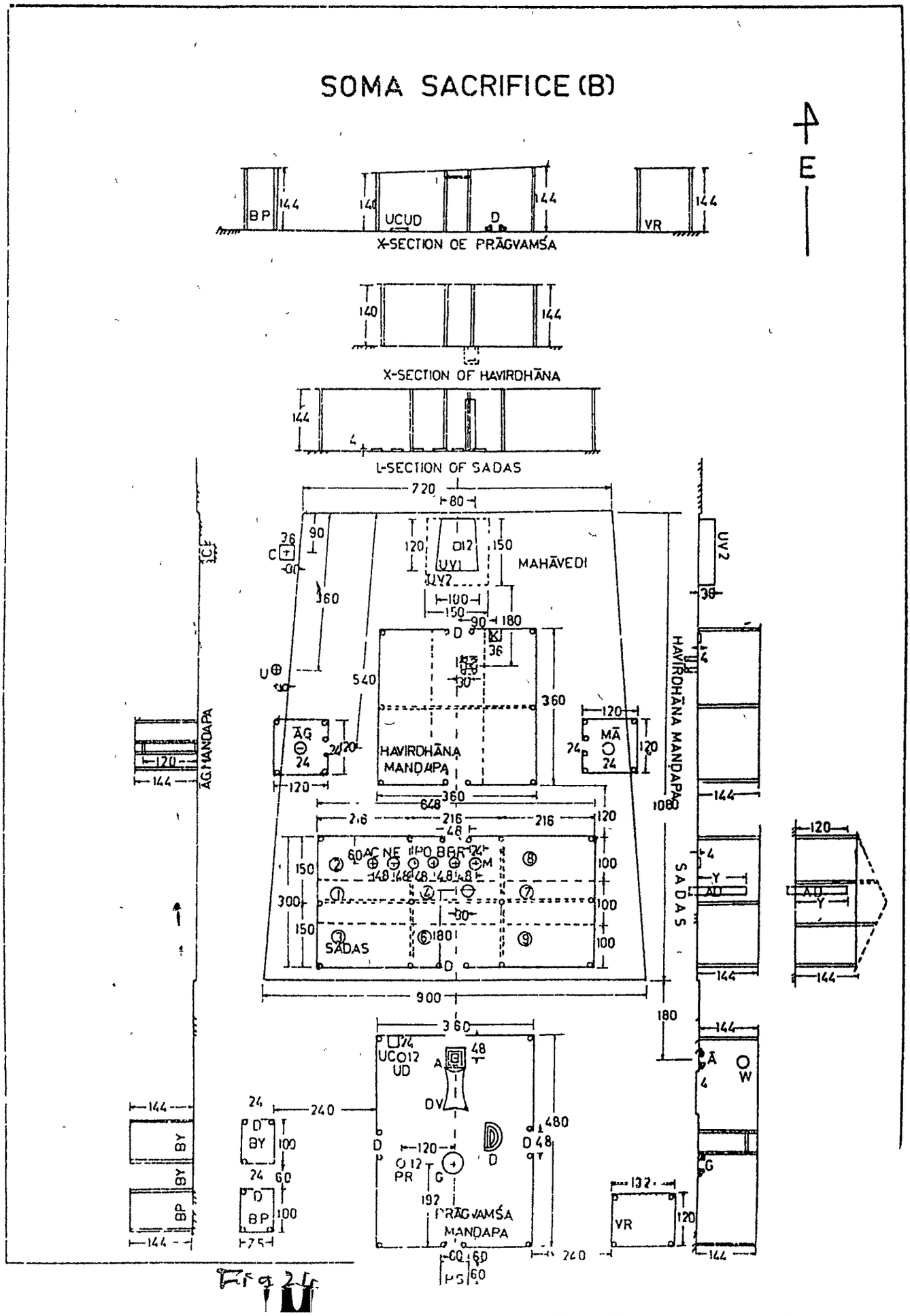

Fig 21

Indological Truths

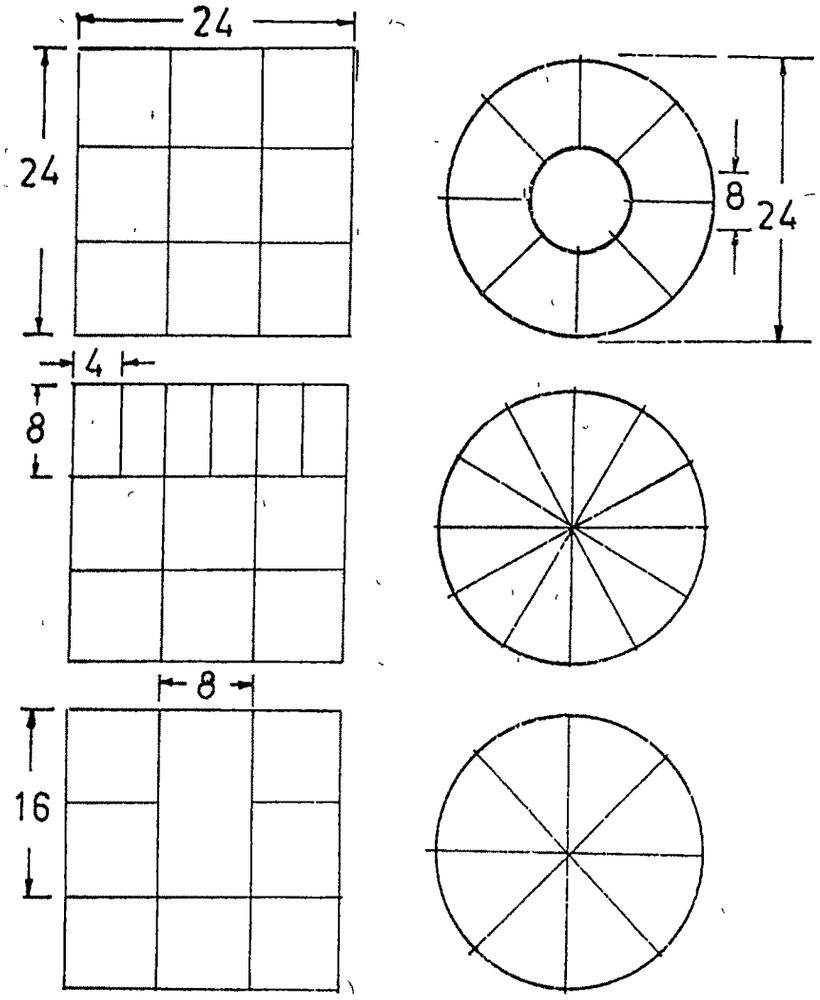

Fig. 6.4 Arrangement of bricks in different dhiṣṇyas
A. Dhīṣṇya of the āgnīdhra (square and circular)
B. The hotṛ's dhiṣṇya (square and circular)
C. Dhiṣṇya of the other priests (square and circular)

Indological Truths

side, 36 along the east-west line and 24 *prakramas* on its eastern side, how it is to be measured out has been explained The Mahāvedi in 6 prakramas from āhavanīya (fire towards east) The 'Saḍas' lies 1 prakramas from there least of the western edge of the Mahāvedi and is 10 prakramas wide (in the east west direction)

The havirdhāna lies 4 prakramas (to the east) from these, it is a square of 10 or 12 prakramas The Uttaravedi is measured out at a distance of half a prakrama to the west of the pole of the *yūpavaṭa* (sacrificial post fixed in pit) According soma sacrifice the *Uttaravedi* measures 10 *padas* The catvāla measure 36 angulas The upavas are each 1 *prādeśa* long, the distance between two of them being 1 prādeśa A square of side equalling one aratni is made, poles are fixed at the (four) corners and a circle of radius equal to half *prādeśa* is drawn situated at a distance of 2 prakramas from the eastern half of the '*sadas*', the *dhisnya* (fires) are each 2 prādeśas in diameter and separated from each other by the same distance (of 2 prādeśa) [21]

The side of the (covered) place for (kindling) the *agnīdhra* (sacrificial fire) is 5 aratnis The doors of the '*mārjālīya*' (covered place for cleaning sacrificial vessels) is made on the northern side The pits for sacrificial posts are placed) at the interval of 1 *aksa* (104 angulas) and there are eleven of them the twenty fourth part of the sum of 10 *aksas*, 11 *padas* and 8 *angulas* is *prakrama* The diagram of the sacrificial chamber with spatial magnitudes as mentioned above is shown in the figure - 24

From the above description of Śulbasūtras, the special magnitudes and construction can be clearly traced to earlier '*Saṃhitā*' and *Brāhmana* [22]

Śulbasūtras in many occasions have actually referred to the authorities of the 'Brāhmana' by name as 'tradition' for the purpose of arriving at a satisfactory conclusion [23]

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21 BŚS 4-1-4-11 [1-88-1 112-3]

22 अथ हैकेशा ब्राह्मण भवति श्येनचिदाग्नीना पूर्वतर्तीति ।
Similarly B S S 6 3 (11 35) and 8 3 (II 5 6) 5-10 (II 16) etc

23 See Appendix II, for the verse 2-9 to 2-15 in Śulbasātras

24 See Table - 8, Appendix I

Indological Truths

All altars with their geometrical shape and measurements according to Baudhayana tabulated and it is given in the Appendix [24]

Relative positions of प्रेताग्नि.

For finding the relative positions of gārhapatya, āhavanīya and daksināgni fires, Baudhāyana has prescribed the following three methods [25]

First method:

Three squares of side one third the distance (between the āhavanīya and the gārhapatya) are made so as to be in contact with each other (along the east-west line) the gārhapatya fire lies at the north west and the daksināgni at the south-east corner of the western square, north-east corner of the eastern square marks the place of the āhavanīya

By the above mentioned positions, mathematicaly it may be explained like this

Let A, G and D stand for āhavanīya, gārhapatya and daksināgni fires The distance AG is divided into three equal parts and with each third part, three square are drawn touching each other, then the north-west corner of the western square, south east corner of the same square and north-east corner of the eastern square mark the places for gārhapatya, daksināgni and āhavanīya fires respectively as shown in the figure below

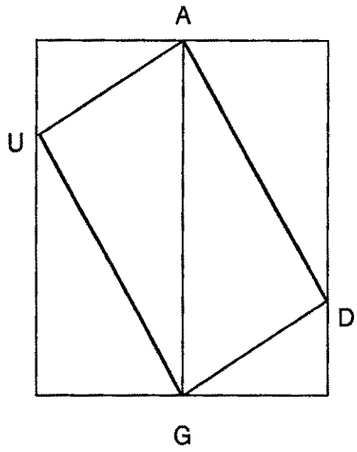
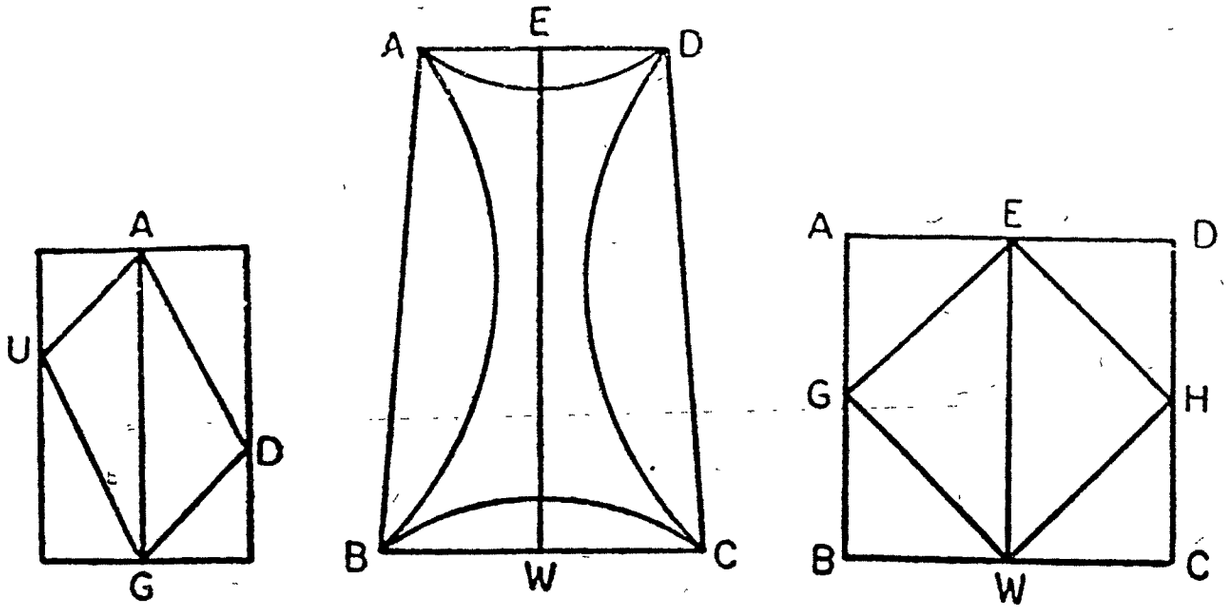


Fig a

25 BŚS 7 4-7 7 (11 61-66)

Indological Truths



Relative positions of Śrautāgnis

Gārhapatya Āhavanīya Anvāhāryapacana (Dakṣiṇāgni

Indological Truths

When A and G ınterchanged position of D i.,e U will denote the [lace for ' Utkara' If 'a' be the dıstance between the and than gārhapatya and āhavanīya then

'Since A G is divided into three parts·

$$AD = \sqrt{\left(\frac{2}{3}a\right)^2} + \underline{a}$$

$$GD = \sqrt{\left(\frac{a}{3}\right)^2} + \sqrt{\left(\frac{9}{3}\right)^2} = \frac{\sqrt{2}}{3}a$$

Where a be the distance between the gārhapatya and the āhavanīya

econd Method:

Alternatively " the distance between the gārhapatya and the āhavanīya ıs divıded nto five or six (equal) parts a sixth or seventh part is added the whole ıs dıvided ınto thıee qual parts, a mark is given at the end of the second part from the eastern extremity (wıth wo ties) fastened to (poles at) the two ends of the (the distance between) the gārhapatya nd the āhavanīya, the cord is stretched to the south by the mark and a pole fixed at (the pot reached by) the mark. This is the place of the dakşıṇāgnı[26]

lathematically, according to this method considering the above figure (a) and above values

$$D = \frac{2}{3}\left(a + \frac{a}{7}\right) \text{ or } \frac{2}{3}\left(a + \frac{a}{6}\right) = \frac{16}{12}a \text{ or } \frac{7}{9}a$$

$$\text{ıd } GD = \frac{8}{12}a \text{ or } \frac{7}{18}a$$

hird Method:

the last method Bodhayana suggests " the measure (between the gārhapatya and the avanīya) is ıncreased by its fifth, the whole of ıt is dıvided into five parts and a mark ıs ven at the end of the second part from the western extremely Wıth two tıes fastened to

---

. B Ś S 3 4

Indological Truths

(poles at) the two ends of the east – west line (representing the distance between two fires), the cord is stretched to the south by the mark and a pole is fixed at (the spot reached by) the mark This is the place of the dakṣiṇāgni

Mathematically here A D = $\frac{3}{5}\left(a+\frac{a}{5}\right)\frac{18}{25}a$

$G D = \frac{2}{5}\left(a+\frac{1}{5}\right)=\frac{12}{25}a$

Āpastamba has taken the second method for the relative position of gārhapatya and the āhavanīya and daksināgni the first method by Kātyāyana He has also specified the relative positions of the three fire- altars also in a new way 'Divide the distance between gāihapatya and the āhavanīya into six or seven parts, add a part, then divide (a cord) equal to the total increased length into three parts etc' The rest of this rule is the same as latter portion of the second rule above and hence need not be mentioned

If it is assumed that the relative positions of the three fire- altars were meant to be one and the same, in cases through expressed differently , then we shall have the following approximations to value of $\sqrt{5}$ and $\sqrt{2}$

$\sqrt{5} = \frac{16}{7}, \frac{7}{3}, \frac{54}{25}$ = 2 285, 2 333, 2 16 respectively

$\sqrt{2} = \frac{8}{7}\ \frac{7}{6}\ \frac{36}{25}$ = 1 142, 1 116, 1 44 respectively

According to modern calculation $\sqrt{5}$ = 2 23607 and $\sqrt{2}$ = 1 144213 comparing the value $\sqrt{5}$ = 2 333 and $\sqrt{2}$ = 1 142 which are correct up to the first place of decimals

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27 Ā Ś S 4-4

Indological Truths

Vedis and their Classification

Introduction :

Vedic rituals are mainly of three classes *Nitya* (which is done on a regular basis), *Naimittika* (which is done on an intentional basis) and *Kāmya* (which is done on an desirous basis) For the performance of these rituals visual elements are almost an integral part like, instruments and tools of yajña Each altar has a specific form, shape and purpose prescribed by a particular Vedic text So an individual who wants to perform these rituals also has the responsibility to make sure that whether all the requirements for doing sacrifices are right form, shape and size

As Vedic rituals are classified Vedis are also classified as- 1) Nityavedis, 2) Kāmyavedis The *naimittika* sacrifices are based on pitrkarmas Hence vedis on these sacrifices are not mentioned in Śulbasātras The vedis of the Nityayajña are primiarily belongs to tretāgnis i e Gārhapathya, Āhavanīya and Daksina The other Nityavedis are- Mhāvedi (Saumika-vedi), Paitrka-vedi, Sautrāmini-vedi, Uttara-vedi etc [28] Kāmyavedis are constructed to achieve special goals, usually demand even more complex geometrical operations and archetectural designs than those needed for Nitya vedis According to the nature of the oblations of sacrifices, they may be subdivided into three groups- 1) Vedis of Iṣṭi yajñas[29] (or sacrifice with oblations of butter, fruit etc), 2) Vedis of Paśu yajña (or animal sacrifice) such as, Nirūḍha paśubandha (which must be performed once every year, more particularly on a new moon or full moon), 3) Vedis of Soma yajña[30] (which is such as Agnistoma, is a very big and extensive so cannnot be performed often But it must be performed or Vedi is constructed sometimes upto one year [31]

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28 Structure and spatial measurements of all Nitya vedis discussed later in page no

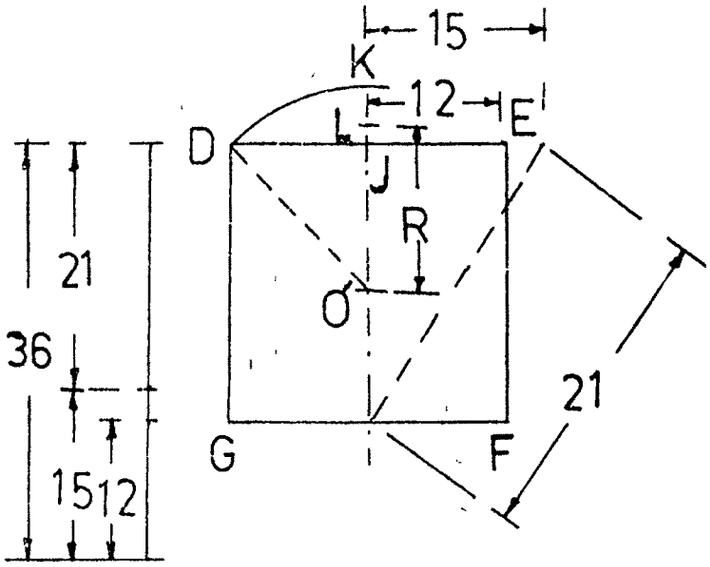
29 An इष्टि means a sacrifice in which the sacrificer employs four priests, the adhvaryu, Brahmā, Hotr and Āgnīdhra are employed

30 The sacrifice where soma is used as oblation

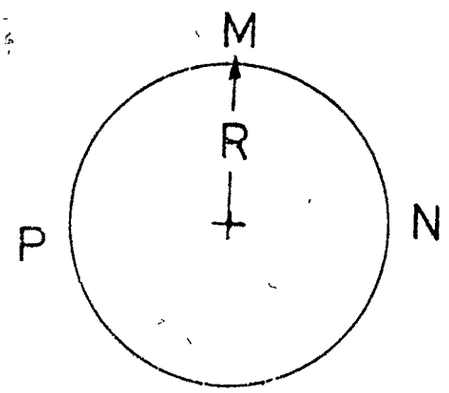
31 For example 'Garuḍacayana'

Indological Truths

The Layout of Fire-Places and Altar (B)



Layout of āhavanīya fire-place



Layout of the gārhapatya fire-place
Area of square DEFG (Fig. 2.4) is equal to the area of the circle PMN.

(26) Figures for Nitya Vedis

Indological Truths

Procedure to give the Layout of the Nitya Vedis:

Śrautasūtras and Śulbasūtras give the proceedures for the layout of different vedis, i e both Nitya and Kāmya vedis

Layout of Nitya Vedis:

As I already mentioned the three sacrifices are to be placed in a proper way Dimensions of the rectangular fire-hall according to BŚr S[32] is length 16 prakramas and width 12 prakramas It is rectangular having east-west sides 16 prakramas (480 angulas) long and north-south sides 12 prakramas (360 angulas) The gārhapatya is located at the centre of the fire-hall

On the east-west centre line of the hall[33] and at a distance of 192 angulas from the western border, fix a peg 'O' It is at the centre of the gārhapatya fire-place Again, on the east-west centre line but at a distance of 240 angulas (i e 8 prakramas) from peg 'O' fix peg 'O' It is at the centre of the āhavanīya fire-place as in the figure - 25

Take a cord of 280 angulas long (240-240/6 angulas) Divide its length in two parts, 180-$^2/_3$ and 93-$^1/_3$ angulas and put a mark C This is the nirāñcehana One end of the cord is fastened to peg 'O' located at the centre of the āhavanīya and another end is fastened to peg 'O' located at the centre of the gārhapatya Stretch the cord towards the south with mark 'C' held in the hand A peg is fixed at the location of the mark C as it is the centre of the anvāhāryapacana fire-place as in the figure - 25

Construction of the Gārhapatya Vedi:

Take a cord and fasten its one end to the central peg 'O' of the āhavanīya fire-place The cord is stretched and fastened to peg D located at the corner of the āhavanīya fire-place Bring this cord of length 'O' D on the east-west central line and put a mark K on this line where peg D is located Divide the distance 'O L which is equal to 'O'J + 1/3 JK Draw a circle of the radius equal to 'O'L with O as centre This is the inside border of gārhapatya fire-place, area of which is equal

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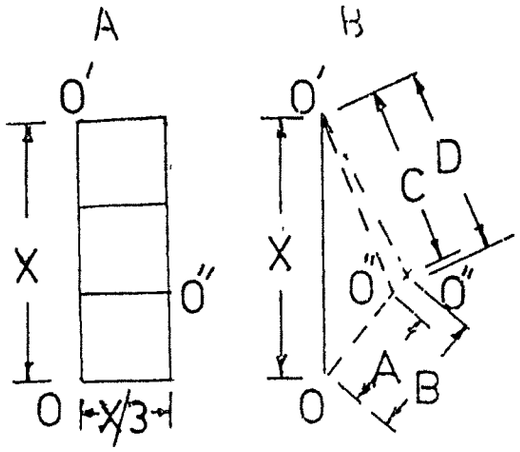
32 प्राग्वशः षोडशप्रक्रमायामो द्वादश व्यास अपि वा द्वादश प्रक्रमायामो। B Śr S 1 58

33 अथापरे प्रमाणदध्यर्धा रज्जुमुभयतः पाशा कृत्वा परस्मिस्तृतीये षड्भागनो लक्षण करोति। B Śr S 1 42
इष्टसार्थम्। पृष्ठ्यान्तयोः पाशौ प्रतिमुच्य न्यञ्छनेन दक्षिणापायम्योष्टेन श्रेण्यसान्तिहरित्॥ B Śr S 1 44

Indological Truths



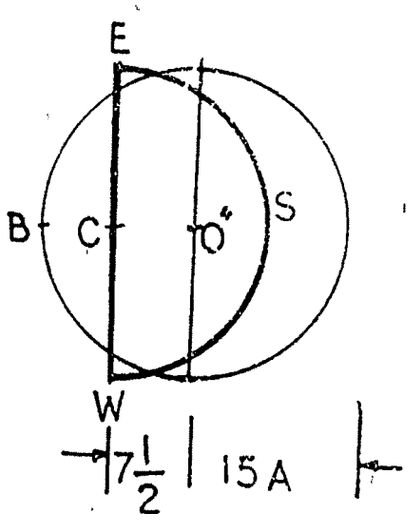
Methods to fix location of Dakṣiṇāgni

(A) X = Distance between centers of the gārhapatya (O) and the āhavanīya (O') fire-places

O'' = Centre of the dakṣiṇāgni

(B) $A = \frac{1}{3}(X + \frac{1}{6}X)$ $B = \frac{1}{3}(X + \frac{1}{5}X)$

$C = \frac{2}{3}(X + \frac{1}{6}X)$ $D = \frac{2}{3}(X + \frac{1}{5}X)$



Method to fix location of the dakṣiṇāgni

Fig – 27

Indological Truths

to 576 sq angulas This is circular gārhapatya Vedi according to B Ś S [34] The diagram is shown in the figure - 26

Construction of the Āhavanīyavedi:

The āhavanīya vedi is square-shaped, length of its sides being 24 angulas Take a cord 1-$^1/_2$ times this length (i e 36 angulas) and draw a square DEFG having sides 24 angulas long Along the east-west centre line of the fire-hall, two pegs 'A' and 'B' are fixed at a distance of 16 prakramas Ends of the cord, 24 prakramas long, are fastened to pegs 'A' and 'B' The cord is stretched towards the south-east by holding it at the mark N Marks N and I are located on the ground at 'N' and 'I' 'Fix a peg at I' This gives the south-east corner Reversing the procedure, fasten ends of the cord to pegs 'B' and 'A' and stretch the cord towards the south-west by holding it at N Fix a peg where the mark I is located This gives a south-west corner Repeat the procedure towards the north and obtain the north-east and north-west corners, so that a square-shaped fire place is formed [35] (See fig 26)

Construction of the Dakṣiṇāgni :

Measure length FD, i e the diagonal of the inner square of the āhavanīya vedi Length of the diagonal is √2x-1 aratni Peg 'O' gives the location of the centre of length equal to the diagonal of the āhavanīya fire-place by the method already described A square of the area equal to two 89 aratnis is obtained Find the radius of the circle of equivalent area by the method elaborated for training the circle representing the gārhapatya fire-place Draw a circle of this radius with peg 'O' as 'centre' Remove the half circle that is towards the north The remaining semi-circle is the daksināgni [36] The diagram is as shown in the figure - 27

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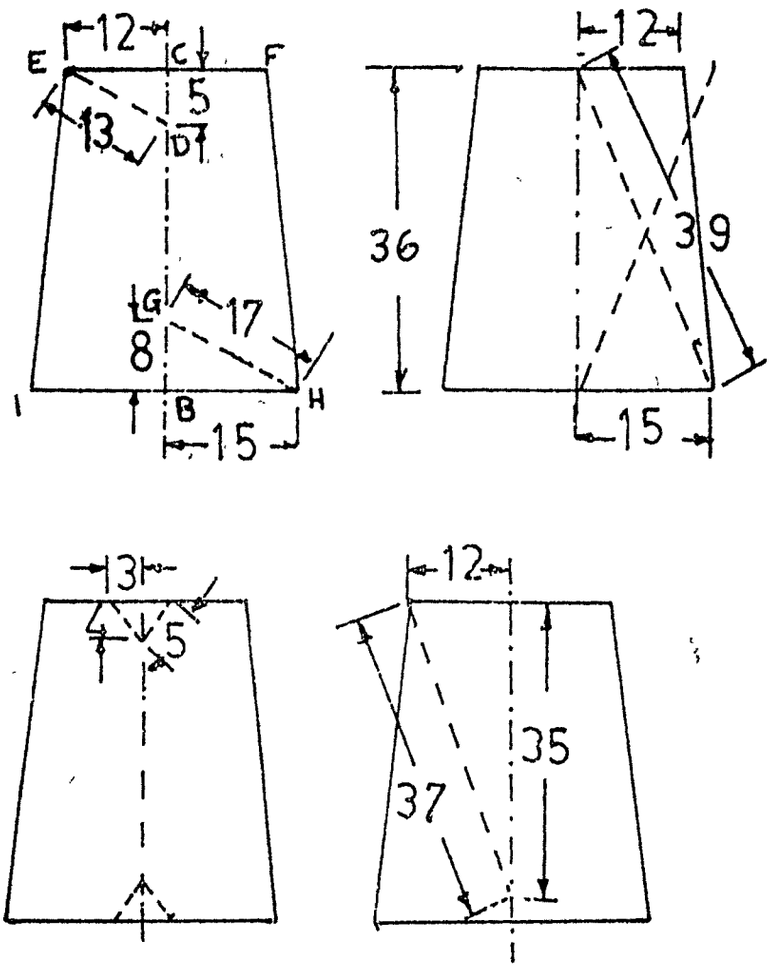
34 चतुरस्रं मण्डल चिकीर्षन्नक्षायार्धं मध्यात् प्राचीमभ्यापातयेद्यदतिशिव्यते तस्य सहतृतीयेन मण्डलं परिलिखेत् । BŚr S 1 58

35 तन्यच्छतम् । 1 43
इष्टसायम् । पृष्ठ्यान्तयोः पाशौ प्रतिमुच्य न्यञ्छनेन दक्षिणापायम्येष्टेन श्रोण्यसन्तिहरित् ।। 1 44

36 अपि वा गार्हपत्याहवनीयोरन्तराल पञ्चधा का षोढा वा सम्भुज्य षष्ठ सप्तम वा भागमागन्तुकमुपसपस्य सम त्रैध विभज्य पूर्वस्मादत्याद् द्वयो भागयोर्लक्षण करोति । गार्हपत्याहवनीयोरन्तौ नियम्य दक्षिणापायम्य लक्षणे शङ्कुम् निहन्ति तद् दक्षिणाग्नेरायतन भवति । B Ś S 1 68 (Commentary)

Indological Truths



The layout of the Mahāvedi (different methods) Fig 28

Indological Truths

Now we find that, the altar of gārhapatya must be of the form of a circle and altar for Āhavanīya should be always a square and that of Daksina semi-circular But the area of each must be same and it is equal to one sq aratni (i e 576 sq angula) From tha construction of these three Nityavedis it will easily be recognised pre-supposes the knowledge of the following geomatrical operations

1) To construct a square on a given stright line

2) To circle a square and it converse of the same area

3) To double a circle

These geometrical operations are very rare even in modern mathematics and geometry behind it is analysed seperately in the chapter

Construction of the Mahāvedi

In a sacrificial chamber the mahāvedi is an important part Śulbasūtras explain the construction of *mahāvedi* in different methods with spatial magnitudes[37] *Mahāveedi* means 'great altar', therefore it is an altar of big size This vedi is important part in soma sacrifice, hence it has another name as 'Saumiki-vedi[38] (or the altar of the soma-sacrifice) As I already described while explaining the construction of fire-hall, it is of the form of an 'isosceles trapezium' in shape That means, the opposite sides are parallel to each other The measurements and area of this type of trapezium which now taught as a subject of Mathematics, under section geometry [39] But in Śulbasūtras, however, explain in connection with the construction of Yajña-vedis" (sacrificial altars) Therefore, from mathematical point of view, the ancient Indian geometrical thought was really considerable

According to Śulbasūtras, the face of mahāvedi is 24 padas (or prakramas) base 30 padas and altitude 36 padas But Baudhāyana said, "according to tradition the mahāvedi measures 30 padas or prakramas on its western side, 36 prakramas along

37 B S S 4 3 (I 91)

38 Ā Ś S 5 1

39 See 'A Text Book of Mathematics 9th Standard', P 258 (State syllabus, Karnataka Govt - 2006)

Indological Truths

the east-west side and 24 prakramas on its eastern side and mahāvedi is[40] located 6 prakramas from the āhavanīya (fire towards east) " As Bodhāyana said,"according to tradition, it is not of his own measurement This matters contained in Śulba to the earlier, Brāhmana[41] and Saṃhita "[42] In Śatapatha Brāhmana, the same measurement of mahāvedi is given which can be explained in detail as follows

The method of constructing the mahāvedi, as described in Śatapatha Brāhmana[43] can be explained as follows

"From the post on the east side (of the fire-hall) one proceeds three 'Vikramas' to the east and there fixes a pole which is the middle-hind pole (अन्नपानः) From the middle hind pole, he goes 15 prakramas towards the south and fixes a pole there, this is the south-west corner (of the Mahāvedi) From the middle hind pole, he proceeds 15 prakramas towards the north and fixes a pole there, it is the north-west corner From the middle hind pole he goes 36 prakramas towards the east and fixes a pole, this is the middle front pole From the middle front pole, he strides 12 prakramas towards the south and fixes a pole, he strides 12 prakramas towards the north and fixes a pole there, this is the north east corner which gets the measurement of the 'Mahāvedi' [44] The setting up of mahāvedi described above may be shown in the diagram as follows

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40 B Ś S 4 3 (I-91)

41 Śat Br III-5 1 6

42 Tai Saṃ IV 2 4 5

43 सद्य एव पूर्वार्ध्यो वर्षिष्टः स्थूणाराजो भवति । तस्मात् प्राङ् प्रक्रामति त्रीन् विक्रमास्तच्छङ्कुं निहन्ति सोऽन्तपातः । तस्मान्मध्यमाच्छङ्कोः । दक्षिणा पञ्चदश विक्रमान् प्रक्रामति तच्छङ्कु निहन्ति सा दक्षिणा श्रोणिः । तस्मान्मध्यमाच्छङ्कोः । उदङ्पञ्चदश विक्रमान् प्रक्रामति तच्छङ्कु निहन्ति सोत्तरा श्रोणिः । तस्मान्मध्यमाच्छङ्को । प्राङ् षट् त्रिंशत् विक्रमान्

44 प्रक्रामति तच्छङ्कु निहन्ति सपूवार्धः । तस्मान्मध्यमाच्छङ्को । दक्षिणा द्वादश विक्रमान् प्रक्रामति तच्छङ्कु निहन्ति स दक्षिणोऽसः । तस्मान्मध्यमाच्छङ्को । उदङ् द्वादश विक्रमान् प्रक्रामति तच्छङ्कु निहन्ति उत्तरौऽस एषा मात्रा वेदेः ।। Śat Br III, 5 1-6

Indological Truths

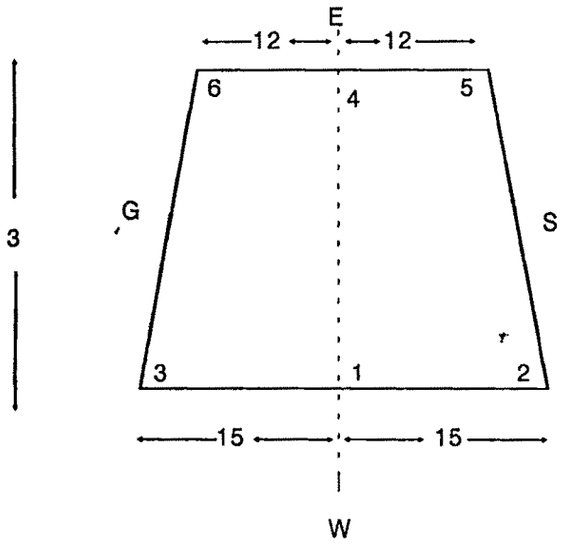

Fig A

मध्यम शङ्कु central peg

दक्षिण शङ्कु south-west corner

उत्तर श्रोणि north-west corner

पूर्वार्ध eastern central peg

दक्षिण अंश south-east corner

उत्तर अंश north-east corner

Similarly mahāvedi, as described in the Taittirīya Saṃhitā, is also in the same form having its face 24 prakramas long, base 30 prakramas and altitude 36 prakramas [45] The measures are also given in other saṃhitās [46] Thus the measurement of the all sides of the mahāvedi and its altitude contained in the Śulba indead, to the earliar Brāhmana and Samhita But it gives the impression that lengths of the sides of the mahāvedi are neither accurately measured nor the eastern and the western sides are laid accurately parallel to each other The Śulbasūtras give good information on different methods of giving layout of the mahāvedi accurately But the love of tradition of these Śulbasūtrakāras is such that, as I have shown before, although the difference of period of Bodhāyana (800 B C) and that of Kātyāyana (300 B C) is

45 त्रिंशत् पदानि पश्चात् तिर्यञ्चि भवति षट्त्रिंशत् प्राची चतुस्त्रिंशतः पुरस्तात् तिरश्चिदशदश सम्पद्यते । Tai Sam 6 2 4 5

46 Mai S 3 8 4, Kath S 25 3, KPS 3 8 6

Indological Truths

very large, still one finds from the study of their Śulbasūtras, that there was same tradition followed in almost five hundered years I think, this is because Indians like to follow old traditions in their religious activities

Here or anywhere else in this Śatapatha Brāhmana, we are also not taught how to draw the east-west line and how to draw a line at right angles to it (i e the north-south line) through a given point on it But one thing is important, the Śatapatha Brāhmana, is known to have measured the vedi with a cord Śulbasūtras also used for measurement with much better and accurate information from the Brāhmana

Layout of Mahāvedi according to Śrauta and Śulba sūtras:

I already explained the construction of Mahāvedi described in Śatapatha Brāhmana Śrautasūtras are also based on Brāhmana texts given the layout of Mahāvedi with measurements The description of layout of Mahāvedi of the soma sacrifice, given in B Śr S gives the impression that lengths of sides of the vedi are neither accurately measured nor the eastern and the western sides are laid accurately parallel to each other

The Mahāvedi should be located towards the east of the fire-hall According to B Ś S [47] distance between the western side of the Mahāvedi and the centre of the āhavanīya fire should be six prakramas (180 angulas) The peg located on the prsthyā (central line) and the mid point of the western side of the Mahāvedi is called 'Śālāmukhīya'[48] peg Dimensions of the Mahāvedi should be

Western side 30 prakramas or padas

Eastern side 24 prakramas or padas

length 36 prakramas or padas

The B Śr S gives the graphic description of the layout of the Mahāvedi It is given below

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47 आहवनीयात् षट् प्रक्रमान्महावेदिः । B Śr S 1 91

48 त्रिंशत् पदानि प्रक्रमा वा पञ्चात्तिरश्ची भवति षट्त्रिंशत् प्राची चतुर्विंशति पुरस्तात् तिरश्चीति महावेदेर्विज्ञायते मानयोगस्तस्या व्याख्यातः ॥ B Śr S 1 90

Indological Truths

"The adhvaryu should measure six prakramas (180 angulas) towards the east in front of the āhavanīya fire There he should fix a peg which is called Sālāmukhīya peg He should measure 36 prakramas towards the east along the prsthyā from Śālāmukhīya peg, there he should fix a peg This is called Yūpāvatīya peg (i e the peg indicating the location of the pit for the sacrificial post) He should measure 15 prakramas towards the south and 15 prakramas towards the north from the Śālāmukhīya peg At these points he should fix up two pegs They denote the buttocks (the south-west and north-west corners) of the Mahāvedi He should measure 12 prakramas towards the south and 12 prakramas towards the north from the yūpāvatīya peg At these points he should fix two pegs They denote two shoulders (the south-east and the north-east corners) of the Mahāvedi Then he should measure the Mahāvedi with a diagonal measure and stretch out a cord around it on all sides He should stretch out the prsthyā line [49] The diagram is as shown in the figure - 28

B Śr S further states that the adhvaryus should do the first tracing of the Mahāvedi He should dig up The āgnīdhra should carry the earth, three times from the ground which has been dug up This discription indicates that the Mahāvedi is dug up below the ground level [50] The depth to which it should be dug up is not given It is specified that the ground of the mahāvedi should be made level by breaking up the pieces of high ground and by filling up the low-laying area Care should be taken while levelling the ground, that is well slope towards the north-east One of the specification for selecting the site of the soma sacrifice is that ground should naturally be slopping towards the north-east This specification helps the preparation

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49 स आहवनीयादेवाग्रे षट् प्राचः प्रक्रामान् प्रक्रामति । तच्छङ्कु महन्ति । स शालामुखीयः शङ्कुः ॥ शलामुखियाच्छङ्को षट्त्रिंशत्प्राचः प्रक्रमान्प्रक्रामति ॥ तच्छङ्कु निहन्ति ॥ स यूपावटीयः शङ्कुः ॥ शालामुखीयाच्छङ्कोः पञ्चदश दक्षिणा प्रक्रमान्प्रक्रामति पञ्चदशोदीचः ॥ तच्छङ्कु निहन्ति । ते श्रेणी ॥ यूपावटीयाच्छङ्कोर्द्वादश दक्षिणा प्रक्रमान्प्रक्रामति द्वादशोदीचः ॥ तच्छङ्कु निहन्ति ॥ तावसावर्थनामक्ष्णयामानेन प्रमाय समन्तस्पन्चया परिश्चिनोति ॥ पृष्ठ्यामातनोति ॥ B Śr S 6 22

50 उदन्ति । उद्धतादाग्नीध्रीस्त्रिर्हरति । यदाग्नीध्रस्तिर्हरत्यथाग्रेण शाला तिष्ठन् सप्रौषमाह वेदिकारा वेदिं कल्पयत प्रस्थलानि भिन्दत प्रति निम्नान्पूरयत किं शास्त्राणि निरस्यत प्राचीमुदीची प्रणवा निस्तिष्ठतेति । यथा सप्रौष ते कुर्वन्ति । B Śr S 6 23

Indological Truths

of the ground of the mahāvedi, sloping towards the north-east The main work, that is required to be carried out for the preparation of the Mahāvedi, is to flatten the pieces of the high ground and to fill up the local depressions It is further mentioned that beards of corn should be removed from the ground of the mahāvedi

Mahāvedi, according Āpastamba:

Āpastamba explained the layout of Mahāvedi almost similar to BŚS All the dimensions of the mahāvedi is same as that of BŚS Bodhāyana says, "mahāvedi is 6 prakrama from āhavanīya"[51] while Āpastamba says, "as a distance of three prakramas"[52] towards the east from the eastern side of the fire-hall, on the prsthyas a peg should be fixed This gives the mid point of the western side of the mahāvedi The depth to which mahāvedi is dug up below the ground level is not given But Āpastamba says "the level of the mahāvedi should be three angulas below the ground level "[53] Besides these differences, the method of Āpastamba in the construction of mahāvedi has special consideration That can be discussed now

What is Rajjuvidhi?

As it has already been discussed in chapter 2, the word rajju means rope or a cord which is used as a measuring tape [54] Therefore it is quite probable that rajju had its use in land surveying Āpastamba has used 'one cord' (Yeka rajju) and two cords (Dvī rajju) in the construction of the mahāvedi[55] This type of construction is different from that of BŚS The method of measuring by one cord is called 'ekarajjuvidhi', while the method of measuring mahāvedi with two cords in named as 'dvīrajjuvidhi' These two methods are very helpful in the construction of altar of the shape of square, rectangle, triangle and many other isosceles trapezum described

51 B Śr S 4 3

52 Ā Śr S 5 1

53 ĀŚrS 5 3 (Karavindiya Vyākhya, 20-22)

54 See Chapter 2, Page No

55 He has named it as 'Saumikīvedi' is same as mahāvedi

Indological Truths

in the Śulba[56] In this methods the knowledge of the properties of the right angled triangle, clearly identified It has been analysed in a separate chapter [57]

Ekarajjuvidhi:

It was given by Āpastamba[58] as "Having joining a cord of 18 prakramas to another 36 prakramas and a mark is given at a distance of 12 prakramas Similarly, another mark has at a distance of 15 prakramas from its western end Having fastened the ends of the cord to (the two poles at) the two extremities of the east-west line (of 36 padas) stretch it towards the south by taking by the mark at 15 and fix a pole (at the point reached by the mark), similarly towards the north These poles are the two western corners of the vedi For (determining) the two eastern corners, interchange (the ends of the cord) and then stretching it towards the south by the mark at 15, fix a pole at (the point reached by) the mark at 12 (proved) similarly towards the north These are the two eastern corners This is the method of construction with one cord [59] (एक रज्जुविहरणम्)

Mathematicaly it can be explained in this way

Let AX be the original cord 'a' measuring 36 prakramas and 4 extra cord, $^{a}/_{2}$ measuring 18 prakramas

C and D are marks on the cord such that

D Y = $^{a}/_{3}$ = 12 prakramas

X C = $^{5}/_{12}$a = 15 prakramas

YC = 1/2 - $^{5}/_{12}$a = $^{a}/_{12}$. AC = $^{13}/_{12}$a

Now a2 + $^{5}/_{12}a^2$ = $^{13}/_{12}a^2$

---

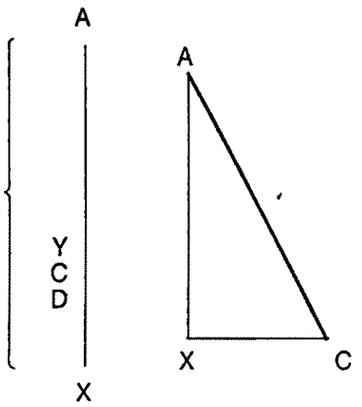
56 Ā Śr S 1 2, 5 1-2, 6 3-4, 6 6-7, 7 1-7

57 See Chapter, Page No

58 Ā Śr S 5 2

59 Āp Sl V-2

Indological Truths



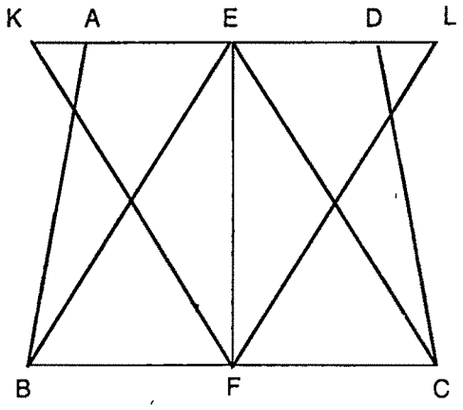


Fig 1 Fig 2 Fig 3

This right angled triangle has been used for the construction of the isosceles trapizium ABCD where ΔAXC, EFC, EBF, ELT and DKF are equal and DX=AE=ED and XC=BF=FC ΔEBC & ΔKFL are in the form of isosceles triangle This shows the geometry lies in the construction of the Mahāvedi

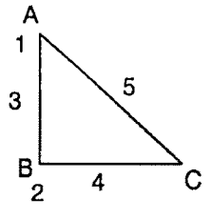
Method II These rules deal with the construction of a Mahāvedi 'with the help of' two pieces of cords Āpastamba here gives three sets of two cords -methodology and analytic methodology This is as follows

Set 1 The diagonal of a rectangle whose sides are 3 and 4 (pada or prakrama) is 5 With them, increased by three times themselves (are determined) the two eastern corners of the vedi With them increased by four times themselves (are determined) the two eastern corners of the vedi

With them increased by four times themselves (are fixed) the two western corners [60] Here Āpastamba applied his own theorem of "भुजकोटि कर्णन्याय"

Mathematicaly it can be done as follows [61]

Sides are 3, 4, 5 ($\because 3^2+4^2 = 5^2$)



60 दीर्घस्यक्ष्णयारज्जुः पार्श्वमानी तिर्यङ्मानी च यत् पृथग्भूते करतस्थदुभय करोति । Ā Śr S 1 4

61 Ā Sr S 5 3

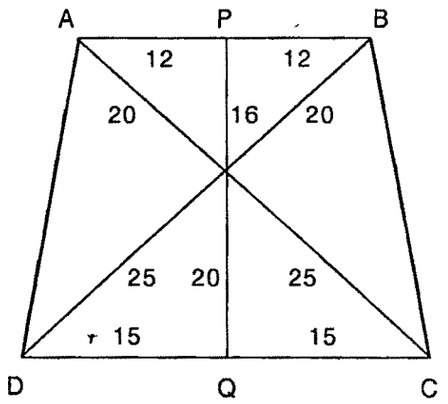
Indological Truths

Increased by 3 times $(3 + 3\ 3)^2 = 12$

$4 + 3\ 4 = 16$

$5 + 3\ 5 = 20$

i e $12^2 + 16^2 = 20^2$



Increased by 4 times

$3 + 4\ 3 = 15$

$4 + 4\ 4 = 20$

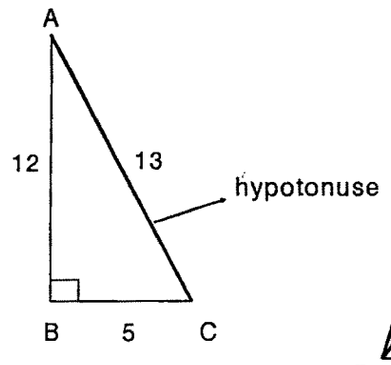
$5 + 4\ 5 = 25$

i e $15^2 + 20^2 = 25^2$

This is also the relationship of finding the lengths of a right angled triangle in geometry of modern mathematics

Set 2 "The diagonal of a rectangle whose sides are 5 and 12 is 13 with them the eastern corners of the vedi (are determined) and with them increased by twice themselves the western corner (are fixed)"[62]

The diagonal of a rectangle of sides 12 and 5 is 13 with these sides, the two eastern corners of the altar and with these sides increased by twice themselves, the two western corners are determined [63]



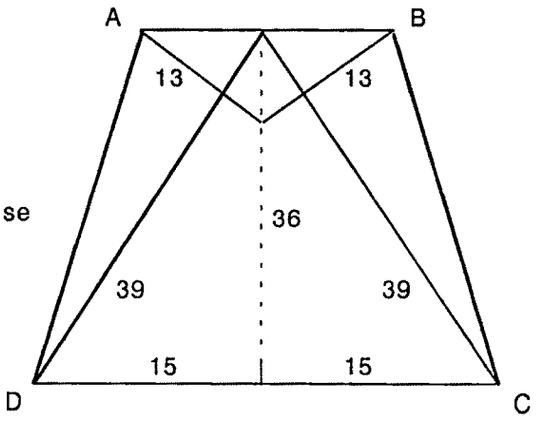


Fig c

62 Ā Su 5 5-4

63 Ā Śr S 5 4

Indological Truths

As shown in the fig(c), If AB=12 & BC=5, then

$$AB^2 + BC = 12^2 + 5^2 = 144 + 25 = 169 \text{ -(1)}$$

$$AC = 13 \; AC^2 = 13^2 = 169 \text{ -(2)}$$

Therefore, by comparing equation 1 & 2 $AB^2+BC^2=AC^2$

Hence the relation is, 12 and 5 in 13 are the sides of a rectangle In another way, "In a right angled triangle the square on the by potenus is equal to the sum of the squares on the remaining sides" This is universally accepted as 'Pythagoran theorem[64] About the Greek mathematician Pythagoras, it will be explained later in a separate chapter - 6

Now these length of the sides have been increased four times i e

i e $5 + 2\,5 = 15$

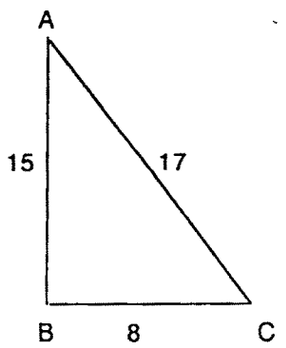
$12 + 2\,12 = 36$

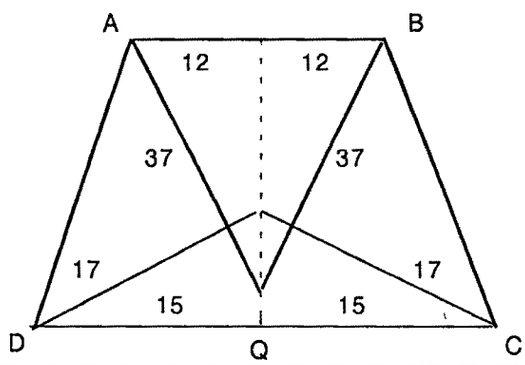
$13 + 2\,13 = 39$

$15^2 + 36^2 = 39^2$ - This relation also holds good in finding the length of sides of right angled triangle in modern mathematics

The diagonal of a rectangle of sides 15 and 8 is 17 With these sides the western corners of the altar are determined

The length of the sides of a rectangle are 15 8 and 17, then the relationship is $8^2 + 15^2 = 17^2$





64 See 10th Standard Mathematics text book (State syllabus) of Karnataka Govt, 2006

* पञ्चदशिकाराष्टिकयोः ससदशिकाष्ट्या रज्जुः ॥ Ā Śr S 5 13

Indological Truths

The diagonal of a rectangle of other sides are 12, 35 & 37 Its relation is

$12^2 + 35^2 = 37^2$

The diagonal of these sides are fixed to the two eastern corners as shown in the figure above

By these two sets of illustration given by Āpastamba, the method of construction explained as follows

"Take a cord 25 prakramas long and divide it in two parts, one being 13 prakramas and another 12 prakramas long

Fasten ends of the cord to pegs C and D and stretch it towards the north, holding the mark in the hand Fix peg E at the point where the mark on the cord is located This is the north east corner of the mahāvedi Repeat the procedure towards the south and obtain the south-east corner of the altar [65]

Mahāvedi According to Manava and Kātyāyana

In the layout of the Mahāvedi in soma sacrifices Manava and Kātyāyana follow the same measurements and methods of Baudhāyana and Āpastamba with some slight differences In Manava the ground of Mahāvedi is dug up so that its level is two or four angulas below the ground level whereas Baudhāyana did not say about the width of digging

Construction of Manava's method of Mahāvedi is as follows "Measure a distance of three prakramas (72 angulas) or a little more along the prsṭhyā (the central line) from the east side of the fire-hall and fix a peg This is the central peg of the western side of the Mahāvedi The east-west length of the Mahāvedi should be 36 prakramas[66] as shown in the figure According to M Śr S length of the western side

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∇ द्वादशिकापञ्चत्रिंशकयोस्सप्त ताभिरसौ ।। त्रिंशिकादक्ष्णया रज्जुः ।। Ā Śr S 5 5

65 द्वादशिकापञ्चिकयोस्त्रयोदशिकाक्ष्णया रज्जुः ।। Ā Śr S 5 10

66 अग्रेण प्राग्वश त्रिषु प्रक्रमेष्वपरिमिते वावकाशे पृष्ठ्या शङ्कु निहत्य वेदादानप्रभृति वेदि विदधाति ।। षट्त्रिंशत्प्रक्रमा प्राचीत्याम्नात प्रमाणम् ।। M Śr S 2 2 1 5 2

Indological Truths

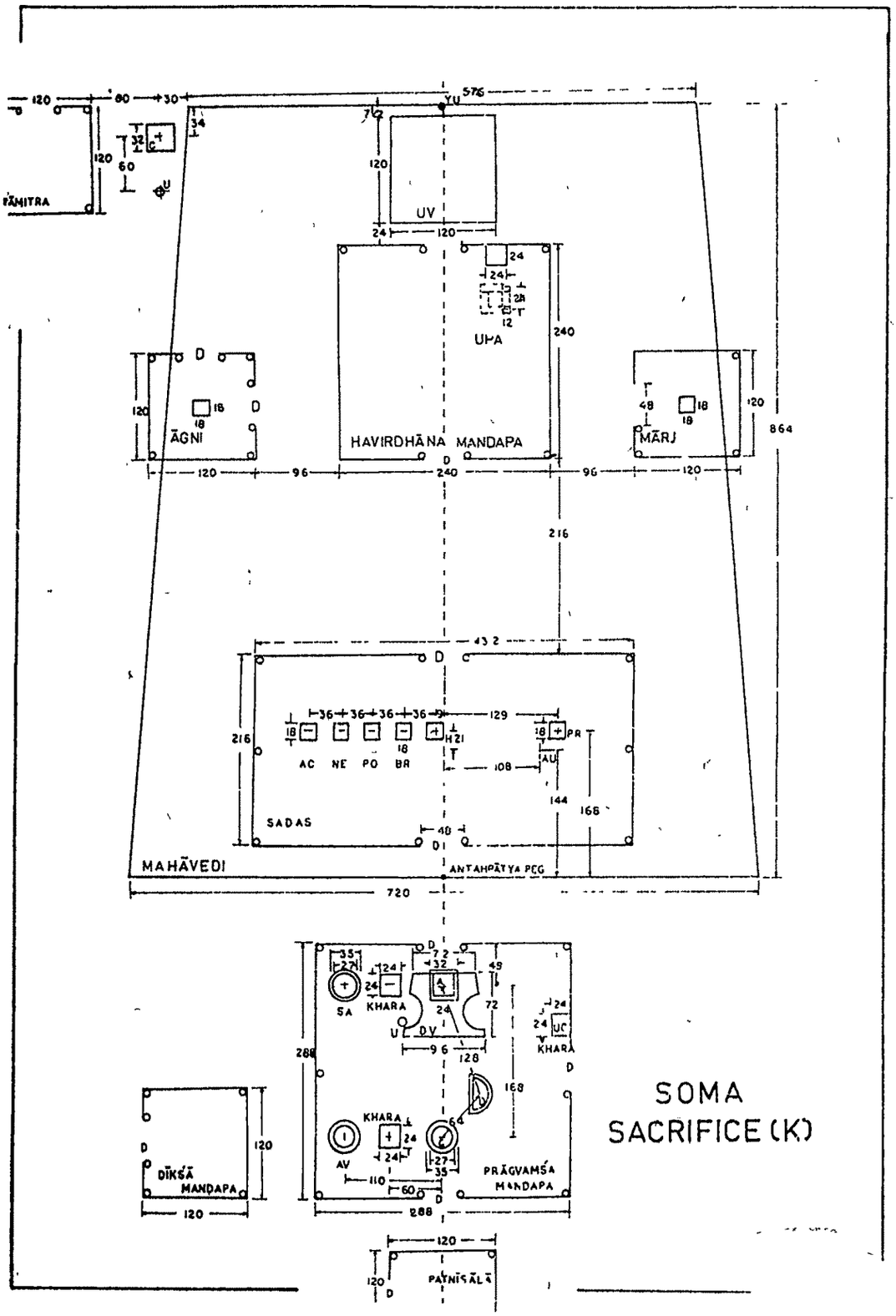

Fig 29

(K) Soma Sacrifice (Scale 0.24 mm = 1 Ang)

Indological Truths

should be 30 prakramas and that of the eastern side 24 prakramas [67] Method of construction of other side of Mahāvedi is quite interesting

"Take a cord 54 prakramas long and divide it into two parts by a mark Length of one part is 39 prakramas and that of another part .15 prakramas Fasten ends of the cord to two pegs on the prsthyā and stretch towards the south by holding it at the mark Fix a peg where the mark is located on the ground It gives the south-west corner of the Mahāvedi Repeat the proceedure by stretching the cord towards the south and then towards the north and fixing pegs at the distance of 12 prakramas, as marked on the cord, locate the north*-east and the south-east corners of the Mahāvedi[68] as shown in the figure - 29

According to Kātyāyana, 'the distance between the eastern side of the fire-hall and the western side of the Mahāvedi should be three prakramas The prsthyā of the Darśiki vedi should be extended towards the east The prsṭhyā of the Mahāvedi should be along the extended prsṭhyā of the Dārsikīvedi A peg fixed on the prsṭhyā indicating the centre of the western side of the Mahāvedi is called antaḥpātya [69]

Dimensions of the Mahāvedi should be western side equal to 30 prakramas, eastern side equal to 24 prakramas and the distance between them equal to 36 *prakramas*[70] The level of the Mahāvedi should be three angulas below the ground level The *prsthyā* of Mahāvedi is constructed, the width and height each being one angula

From the method of construction of Mahavedi according to Śatapatha Brāhmana and four Śulbasūtras it may lead to the following conclusions

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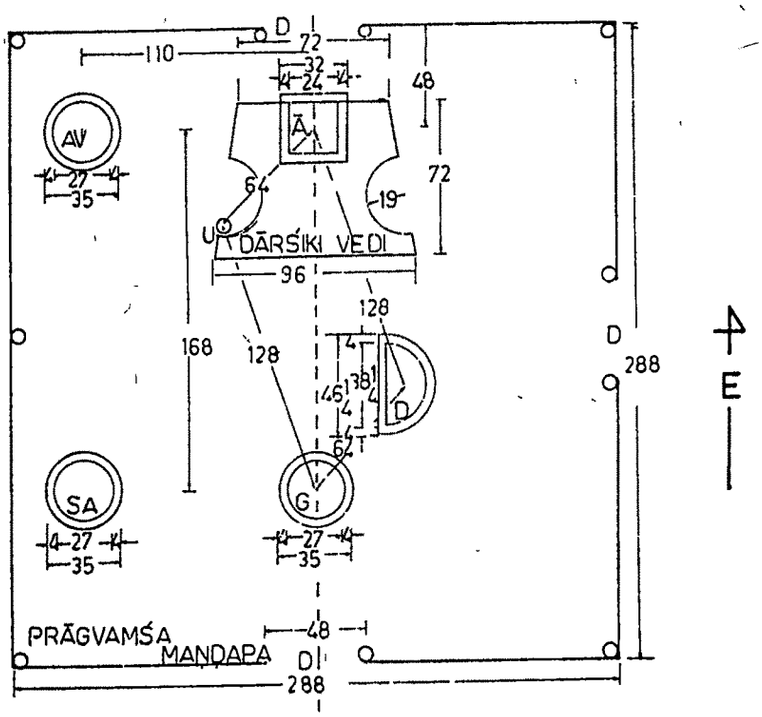
67 लक्षिका द्वादश त्रिका । वेदिसदोहविर्धानानि मितोत्येवानुपूर्वशः पञ्चदशकमेकविंशक त्रिकपर परतोऽपरस्त्रिको द्वादशसु च पाशाद् उच्यते । सोमे रज्जुनिमानमुत्तमम् ।। M Ś S 13 4

68 अन्तरामध्यमे चतुष्पञ्चाशदे प्रक्रामति । प्राग्वशस्य मध्यमाल्ललाटिकान् तीन् प्राचः प्रक्रमान्प्रक्रम्य शङ्कु निहन्ति । तस्मात् पञ्चदशसु दक्षिणतः । एवमुत्तरतः । प्रथममिहिताच्छङ्को एव उत्तरतः । तावसौ ।। M Sr S 2 2 1 5 3

69 पूर्वार्द्धर्यात् स्तम्भात् पुरस्तात् त्रिषु प्रक्रमेषु शङ्कु निहन्ति । सो अन्तः प्राच्यः । K Śr S 8 3 9

70 तस्मात् पुरस्तात् षट्त्रिंशति । दक्षिणोत्तरौ च पञ्चदशसु पञ्चदशसु । अर्द्धसप्तदशेषु वा । पूर्वार्द्धर्याच्च द्वादशाद्वादशासु । पृष्ठ्यामायम्य ।। K Śr S 8 3 8 11

Indological Truths



DARŚAPŪRNAMĀSA SACRIFICES (K)

PLATE 1 (K) Darśapūrṇamāsa Sacrifice
(Scale 0.24 mm = 1 Aṅg)

Indological Truths

i) Śulbasūtrakaras or 'vedi constructors' should know the construction of various geometrical figures only with the help of simple instruments like cord and pole (śanku)

ii) They also know about finding the area of difficult geometrical diagram like isoscales trapezium for the given lengths of face, base and altitude as like modern mathematicians

iii) To find the measurement of geometrical figures like these isoscales trapezium, the state of knowledge of geometry of higher degree was known during the śrauta period or śulbasūtra period The insistance of *Ācāryas* to follow the traditional methods by using simple instruments like cord and pole lead to the impression that the knowledge of geometry was very simple during the śulbasūtra period [71]

Construction of Layouts of Kāmya Vedis:

1 Darśa-paurnamāsa It is a 'model' and primary sacrifices for all istis (brief and simple ceremonies) and where the oblations offered are *purodāśa*-cakes, milk, curds and butter [72] *Agni* and soma are the divinities principally worshipped (Agni-somiya)[73] New moon and full moon days are prescribed for this ritual and doing this sacrifice for getting 'svarga' Darśa pūrnamāsa begins even on the previous day when agnyādhāna (setting up of the sacred fire) is conducted by feeding the three sacred fires (gārhapatya, āhavanīya and daksina) with one faggot (from aśvattha or palāśa tree) each The man who is the sacrificer at noon approaches the three sacred fires and understakes the vows (vrata-grahana) and he spends that night in the sacrificial hall tending the fire

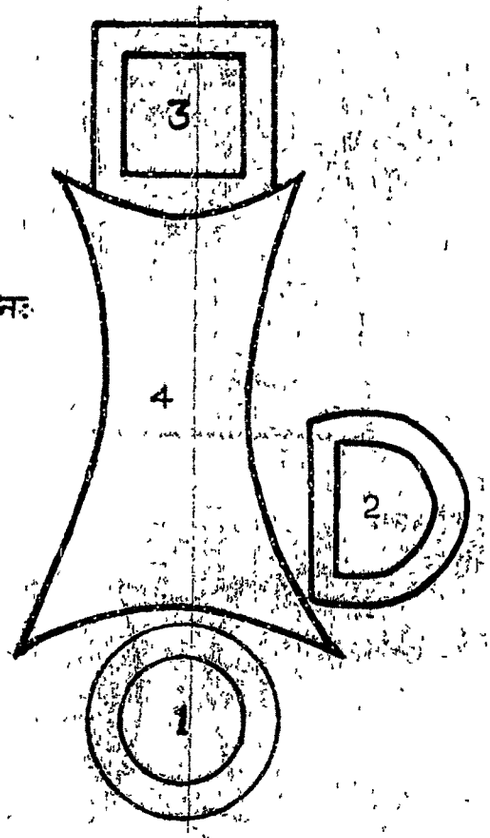
71 For example verses such as 1 65, 1 71, 1-76 of BŚS or verses 4-1, 4-3, 4-5, 5-1, 5-8, 5-10 of ĀŚS and with the remark ''इति विज्ञायते or इत्युपदिशन्ति or इति उक्तम् (verse 1 85 of Bau) all these literal quotations justify that spatial magnitudes or method of construction was said authentically

Indological Truths

दर्शपूर्णमास विहारः

[बौधायनश्रौतसूत्रानुसारेण]

(5)



1 गार्हपत्यः
2 अन्वाहार्यपचनः
3 आहवनीयः
4 वेदिः
5 उत्करः

(स्केल - 1 इंच : २० अंगुलानि)

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GOKARN

Fig (30)

Indological Truths

The remainder of the purodāśa cakes is put into the fire in a sequence called sviṣṭikrt and anuyāja as the fire-ritual for three divinities follows The ritual begins with the establishment of the sacred fire and concludes with the final oblations (pūrnāhuti) Thus Anvādhāna, Samiḍādhāna, Darbhaharana, Sāyamdoha, prātdoha, Nirvāpa, Havispana, Samiḍḍīni, Prayāja are the first stages, while Svistakrt, Iḍābhaksana, Daksnādāna, Anūyāja, Sūktavāka, Śamyuvāka, Patnīsamyāja are the second stages[74] of this Darśapaurnamāsa yajña

Dārśapaurṇamāsika Vedi:

This type of 'vedi' is constructed for Darśapaurnamasa Sacrifice, 'Darśapaurna masa' is one of the śrauta sacrifice and one among seven 'Haviryajñas' This sacrifice is a 'model and primary sacrifice for all इष्टि's and where oblations offered are puroḍāśa-cakes, milk, curds and butter[75] New moon and full moon days are prescribed for this ritual The śulba sūtras deal with rules for measurement and construction of vedi regarding Darśapaurnamāsa[76] This vedi is placed towards the west side of the āhavanīya and is in the form of an isosceles trapezium having face equal to angulas, base 64 angulas and altitude 56 angulas As shown in the fig (a) this vedi lies east side of Gārhapatya and north side of 'Yajamāna'

The formation of this vedi can be stated as follows:

"A tie is given as each end of a cord twice as long as the side (of the base) and a mark at the middle With two ties fastened to (poles at the two ends of) two ties fastened to (poles at the two ends of) the southern side the cord stretched to the south by the mark and a pole fixed at (the spot reached by) the mark Fixing the two

---

72 आग्नेय्यो अष्टकपालः पुरोडाशयागः ऐन्द्रो दधियागः । प्रयाजहोमानन्तर प्रयाजशेषेण हवीव्यभिघारयतीति ।। Śr Yaj Saṃ Chapter 2 19

73 दर्शपूर्णमासाभ्या स्वर्गकामो यजेत । अग्निः । विष्णुः प्रजापतिः आग्निषोमौ । Śr Y Saṃ Chapter 1 43

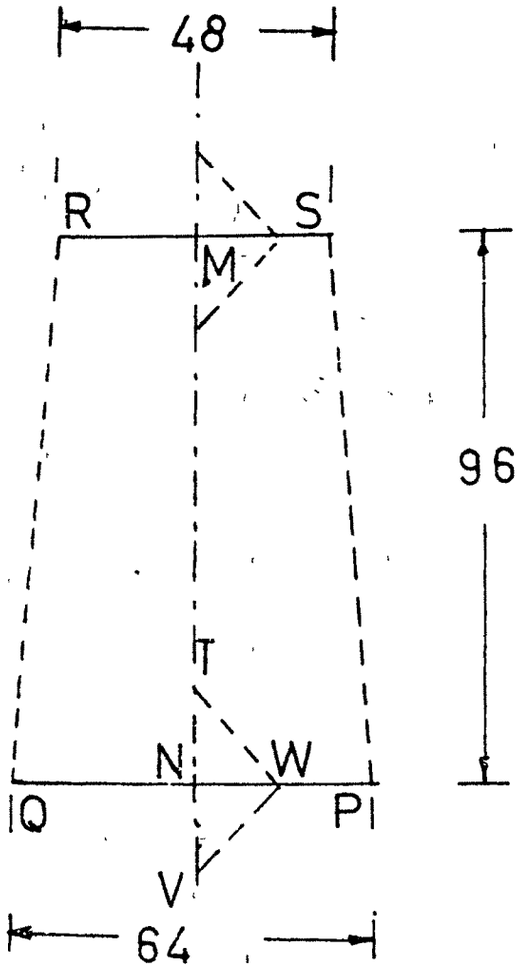
74 पौर्णमास्या त्रीणि प्रधानानि आग्नेयः उपाशुयाज आज्यहविष्कः अग्नीषोमीयः पुरोडाश इति । तत्रेमानि क्रमेण अनुष्ठीयन्ते । शुक्ल यजुः वेद स (Chapter 1-2 - devoted to Darśapūrnamāsa)

75 Śukla Yajurveda Samhitā, Chapter 1 & 2
पौर्णमास्या त्रीणि प्रधानानि आग्नेयः उपाशुयाजः आज्यहविष्कः अग्नीषोमीयः पुरोडाश इति ।। 18

76 B Śr S 3 6-3 8 Ā Sr S 4 5 , M Ś S 1 4

Indological Truths

The Layout of Fire-Places and Altar (B)



Layout of the Dārśikī Vedi – Fig 31

Indological Truths

ties at this (pole) the southern side is circumscribed (with an arc of a circle from end to end) lay the mark Thereby the northern side is explained The eastern side is circumscribed in the same way by a cord double its length, and likewise the western side " (See the figure - 30)

Mathematicaly we can explain as follows since it is in the form of isosceles trapezium, let AD = 48 angula BC = 64 angula & EW = 96 angula

Construction of the Dārśiki vedi with modern notations:

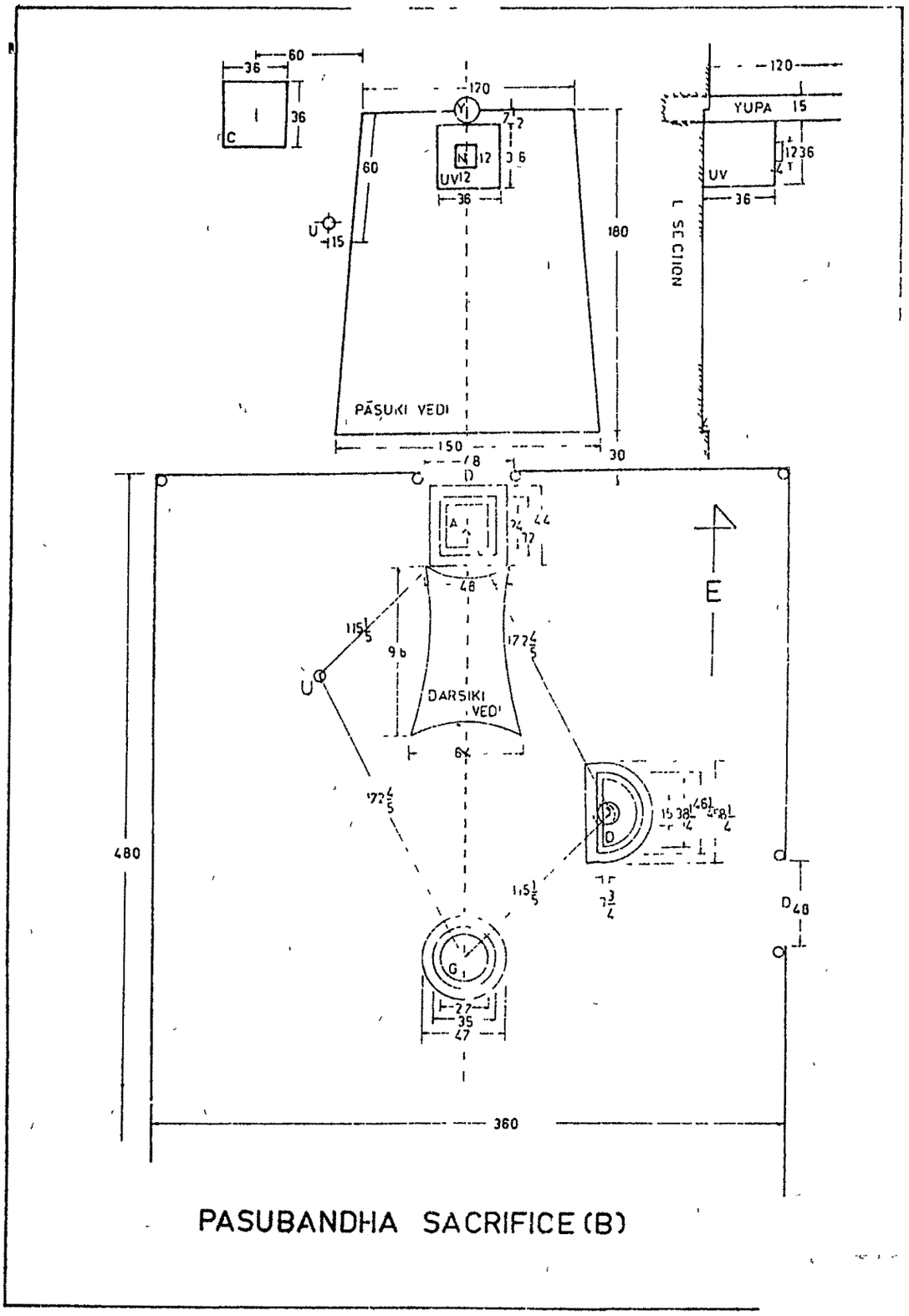
Fix pegs M and N along the east-west line and at a distance equal to the length of the altar, say 96 angulas, distance between the western side of the āhavanīya fire-place and eastern side of the altar is very small or nil Take a cord 64 angulas long Fix two pegs T and V on the east-west centre line at equal distance from the peg N This distance may be 15 angulas Fasten two ends of the cord to pegs T and V Stretch the cord towards the south, holding its middle mark in the hand Make a mark W on the ground where the middle of the cord is located Remove knots from pegs T and V and fasten them to peg N Stretch the cord holding its mid-mark in the hand such that it should be aligned along the mark W Fix peg P at the point where the middle mark is located This gives the south-west corner of the Darśiki altar Repeat the construction towards the north and obtain the north-west corner Fix two pegs at the distance of 15 angulas on both sides of the peg M along the east-west line Take a cord 48 angulas long and repeating the construction, obtain the north-east and the south-east corners of the Darśikīvedi which is in the form a trapezium[77] RSPQ as shown in the figure - 31 Āpastamba and Manava followed the same method This vedi has a long tradtion and is mentioned in Taittirīya Samhita and Taittirīya Brāhmana

2. The Animal sacrifice (or Paśubandha yajña)

This is an independent sacrifice and it is also performed in soma sacrifice as a constituent part The independent sacrifice is called nirūdhapaśubandha (offering of

77 B Śr S 3 8

Indological Truths



PASUBANDHA SACRIFICE (B)

(B) (Scale 0.24 mm = 1 Aṅg) Fig 32

Indological Truths

an eviscered animal) and the subordinate ones are called saumika The independent animal sacrifice is to be performed every six months or every year by āhitāgni throughout his life If done once, in a year it has to be performed in a rainy season (i e Śrāvana or Bhādrapada) on New moon or Full moon day or it is performed once in six months at the beginning of the southern and the northern passages of the sun (i e. Daksināyana and Uttarāyana) In this sacrifice there is a sixth priest who is called as Maitrāvaruṇa in addition to the five required in the cāturmāsya yajña

The layout of three fire-places, the altar and the fine-hall is similar to that described for the New moon and the Full moon sacrifices

The Pāśubandhiki vedi:

Location of this altar with reference to the āhavanīya fire-place is not given in the fourth praśna of the BŚr S, north in the fifth praśna where description of two altars required for the Varuna praghāsa-parvan is given, as the Uttaravedi is like the Pāśuki vedi

According to the Śrautasūtras[78] the centre line of the Pāśukivedi should be along the prsthyā of the Darśinivedi, which is extended towards the east The altar should be located towards the east of the āhavanīya fire place and the distance between the eastern side of the āhavanīya fire place and the western side of the altar should be 30 angulas (that is two padas) This is the width of the pathway (sañcāra) between the āhavanīya fire place and the altar According to both B Śr S and B Śr S the dimensions of the altar should be east west length 12 padas (180 angulas), east side eight padas (120 angulas) and the west side ten padas (150 angulas),[79] B Śu S [80] gives in addition two more altarnative dimensions and shapes of the altar (a) shape of the altar should be like a isosceles trapezium and its dimensions similar to those

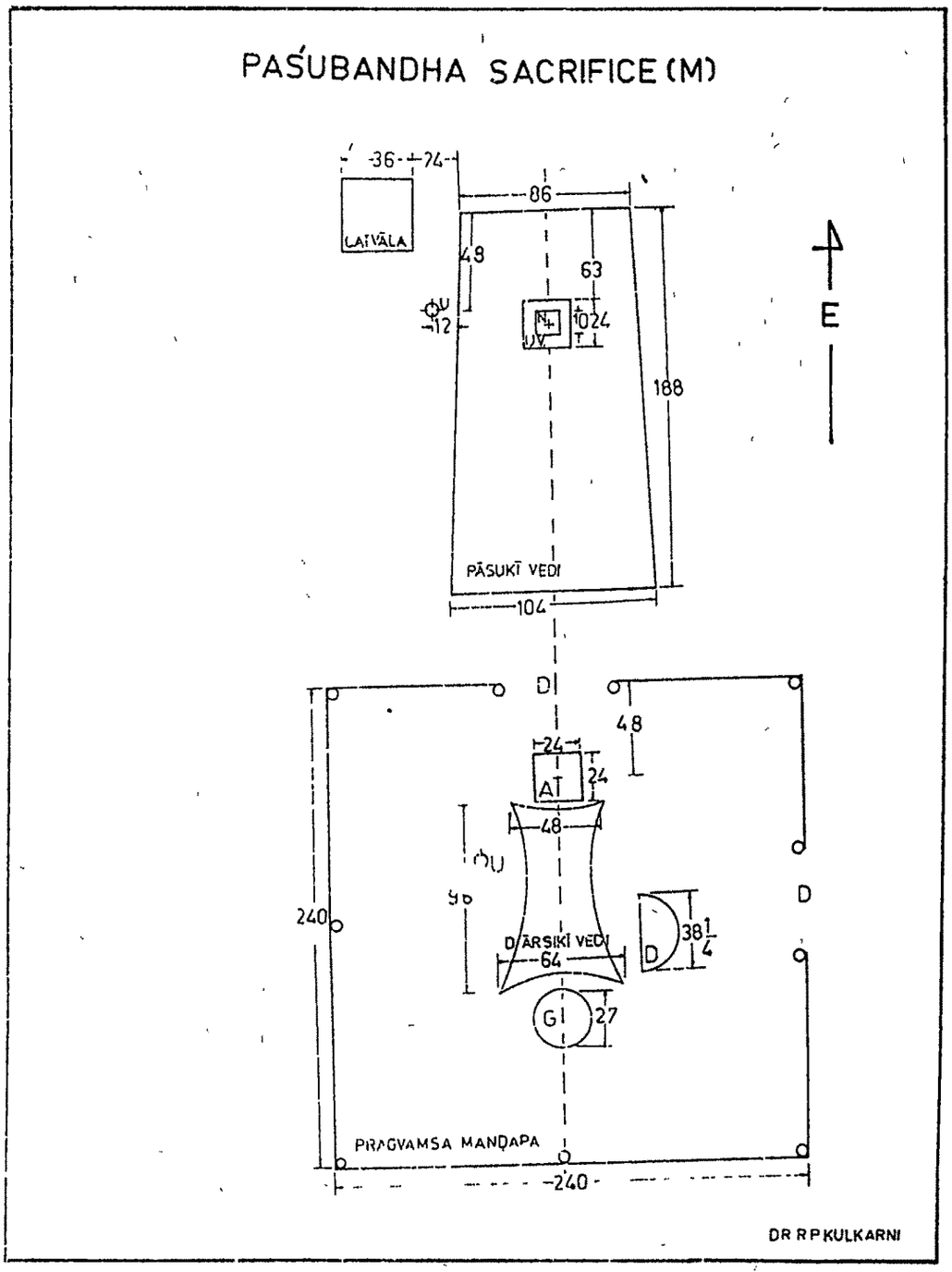
78 B Sr S 1 36-42, Ā Sr S 4 5, Mānava Ś S 1 4, Tai Sam II, 6 4 2-3, Tai Brā III, 2-9-10

79 अध्वर्युः आहवनीयस्य पुरस्ताद् पदद्वय सञ्चरमवशेष्य शङ्कु निहन्ति ।। Ś P N 472/84

80 पूर्वेद्युरेव पाशुबन्धिकी वेदिविमिता भवति दशपदा पश्चात्तिरश्ची द्वादशपदा प्राच्यष्टपदा पुरस्तात्तिरश्ची ।। B Śr S 4 1

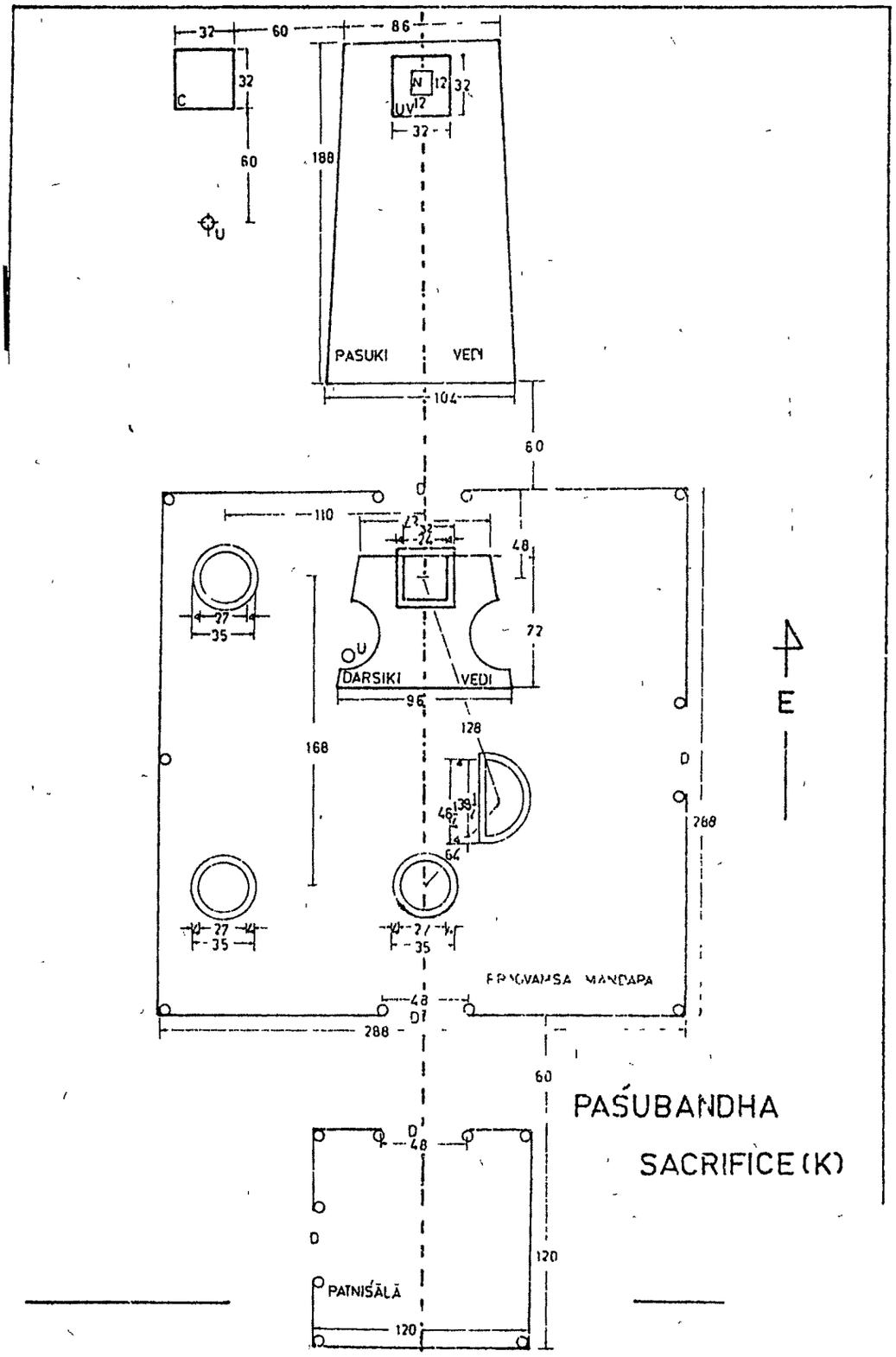
Indological Truths

The Layout of the Animal Sacrifices (M)



(M) Paśubandha Sacrifice (Scale 0.24 mm = 1 Aṅg) Fig 33

Indological Truths



(K) Paśubandha Sacrifice (Scale 0.24 mm = 1 Ang)

Fig 34

Indological Truths

of the chariot as shown in the figure - 32 According to the B Śr S [81] dimensions of the altar, similar to those of a chariot should be length of its east side equal to a yoke i e 86 angulas length of its west side equal to an exle i e 104 angulas and the east-west length equal to a pole i.e 188 angulas (b) The other altar should be a square shaped, length of its sides being ten padas (150 angulas)[82] The construction of *paśubandhikivedi* is also explained by Mānava & Kātyāyana in the similar way (See the figs 33 & 34)

The Uttara vedi should be prepared, like a sthandila near eastern side of the Paśuki vedi -distance between the eastern side of the Uttaravedi and that of the altar should therefore be $7^1/_2$ angulas Uttaravedi should be square shaped and the length of its side being one śamyā (36 angulas)[83]

The catvāla[84] should be located two or three prakramas (60 or 90 angulas) away from the altar towards the north The catvala should be square shaped and its side being one śamyā long The location of the Utkara is not given in the B Śr S or even in B Śu S According to SPN[85] measure a distance of four padas (60 angulas) towards the west from the north east corner of the altar and hence measure a distance of one pada (15 angulas) towards north

The 'sacrificial post' (Yūpa) for an animal sacrifice should be five aratnis long (i e 120 angulas) This is the minimum length those prescribed in the Brāhmana[86] It is mentioned that the sacrificial post should be installed such that one half of it should be inside the eastern side of the altar [87] The diameter of the sacrificial post

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81 दशपदा पश्चात्तिरश्ची द्वादशपदा प्राच्यष्टपदा पुरस्तत्तिरश्चीति पाशुबन्धिकया वेदेर्विज्ञायते । मानयोगस्वस्य व्याख्यातः ॥ B Śr S 1 76

82 Bau Śr S 1 77-70

83 रथ सम्मितेत्यकेषाम् ॥ B Śr S 1 77 अष्टाशीतिशतमीषा ॥ 1 10 चतुःशतमक्षः ॥ 1 11 षडशीतिर्युगम् ॥ 1 11

84 चक्षुर्निर्मिता स्यात् सर्वतो वा दशपदा विराट् सम्पन्नेति शालीकि ॥ B Śr S 20 25

85 B Śr S 1 79-80

86 उत्तरेण बेर्दिद्वयोर्वा त्रिषु वा प्रक्रमेषु स्फ्येनोद्धत्याऽवोक्ष्यशम्यया चात्वाल परिमीते । B Śr S 4 2

87 वेद्युत्तरा सशङ्कमारभ्य प्रत्यक् पदचतुष्टा मीत्वा उदगेक पद मीत्वा शङ्कु निहन्ति स उत्करः ॥ Ś P N 475/85

Indological Truths

The Layout of the Nirūdha Pasubandha Sacrifices (Ā)

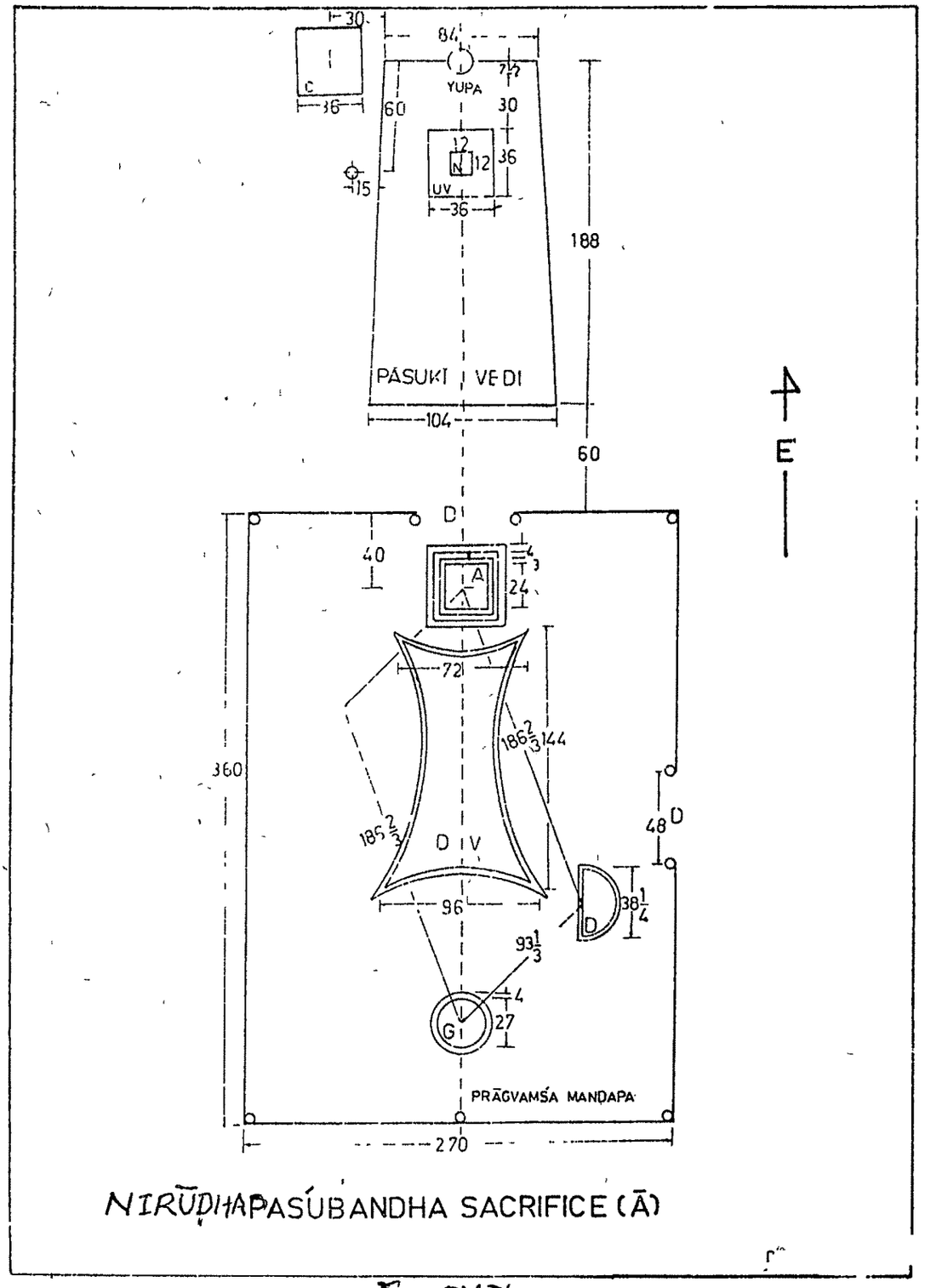

Fig 35

(Ā) Paśubandha Sacrifice (Scale 0 24 mm = 1 Ang)

Indological Truths

is generally, one pada[88] Length of the sacrificial post that would be above the ground level should be square or octogonal in cross section [89] A casala should be made of another piece of wood Its length should be four angulas It should be hollow and inserted over the top of the sacrificial post, such that top four angulas length of the post should be protruding above top of the casāla

3. Nirūḍha Paśubandha sacrifice:

This is an independent sacrifice Here offering of an eviscred (nirūdha) animal is important This sacrifice is to be performed every six months or every year by the āhitāgni throughout his life I already explained the animal sacrifice in detail

Āpastamba has given the layout of the Nirūdha paśubandha sacrifice as shown in the figure - 35

This altar should be located at the distance of 30 or 60 angulas, along the prsṭhyā, towards the east of the fire hall The prsthyā of the Paśuki vedi should be along the extended prsthyā of the Darśikīvedi Dimensions of the altar should be similar to those of the chariot The western side of the altar should be equal to 104 angulas i e equal to the length of the axle of the chariot The length of the eastern side should be 86 angulas, i e equal to yuga and the distance between them should be 188 angulas i e equal to isā The length of the eastern side may be equal to the distance between holes at the ends of the yoke

According to the vyākhyā of Sundararajan this distance between the holes at the under of the yoke should be 80 angulas Karavindīya Vyākhyā states that the distance is smaller by 16 angulas than the length of the yoke, i e should be 70 angulas If further states that it may be smaller by one aratni, i e its length should be 62 angulas

Alternate dimensions of the altar are West side equal to four aratnis (96 angulas), east side equal to three aratnis (72 angulas) and the distance between them equal to six aratnis (144 angulas)[90] sides of the altar should be straight [91]

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88 पञ्चारत्निं तस्मै वृश्चेदिति । एष ब्राह्मणवतामवतः ॥ – B Śr S 4 1

89 तया यूपावट परिलिखति यथाऽन्तवेद्यर्ध स्यात् बर्हिर्वेद्यर्ध परिलिखत । B Śr S 20 26

90 यूपावटाः पदविष्कम्भाः । त्रिपदपरिणाहानि यूपोपराणीति । B Śr Su 1 11-12

91 त चतुरश्रिः वाष्टश्रि वा कृत्वा ॥ B Śr S 4 1

Indological Truths

The Uttaravedi should be located in such a way that its eastern side is at the distance of 30 angulas, equal to sañcara, from the pit dug out for the erection of the sacrificial post The sacrificial post be placed such that its half width should be within the altar and half of it outside the altar [92] The uttaravedi should be square shaped, its side being, one śamyā (36 angulas) long[93] The height of the uttaravedi should be one janu (32 angulas) or three vitastis[94] (36 angulas) At the centre of the uttaravedi, a square shaped nābhi having sides equal to one prādeśa should be provided The size of the nabhi may be like a cow's foot or a Horse's hoof, that is equal to one gopada or aśvaśafa Its height should be four angulas [95]

The catvāla

It should be located at the distance of one prakrama from the north east corner of the pāśuki vedi It should be square shaped, length of its sides being one śamyā or three vitastis Its depth should be one janu

Paiṭṛki vedi for Pitṛ-rites

A Paitṛiki vedi should be constructed for performing Mahapitr yajña Towards the south, there should be prepared a level piece of ground The adhvaryu should trace out upon it a square altar He should not dig it up In the centre of the altar, he should enkindle the anvāhāryapacana fire [96] Baudhāyana says that one should go out of the fire hall and prepare the altar in the south east Śaliki says that one should prepare it in the south east but within the fire hall itself Aupamanyava says that one should prepare it round the anvāhārya pacana fire [97]

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92 श्यमात्री निरूढपशुबन्धस्य वेदिः ॥ अक्षसम्मिता पश्चात्तिर्यगीषया प्राची विपथयुगेन पुरस्ताधावता वा बाह्ये छिद्रे ॥ Ā Śr S 2 37

93 श्यमात्री निरूढपशुबन्धस्य वेदिर्भतीति विज्ञायते ॥ Ā Śr S 6 6

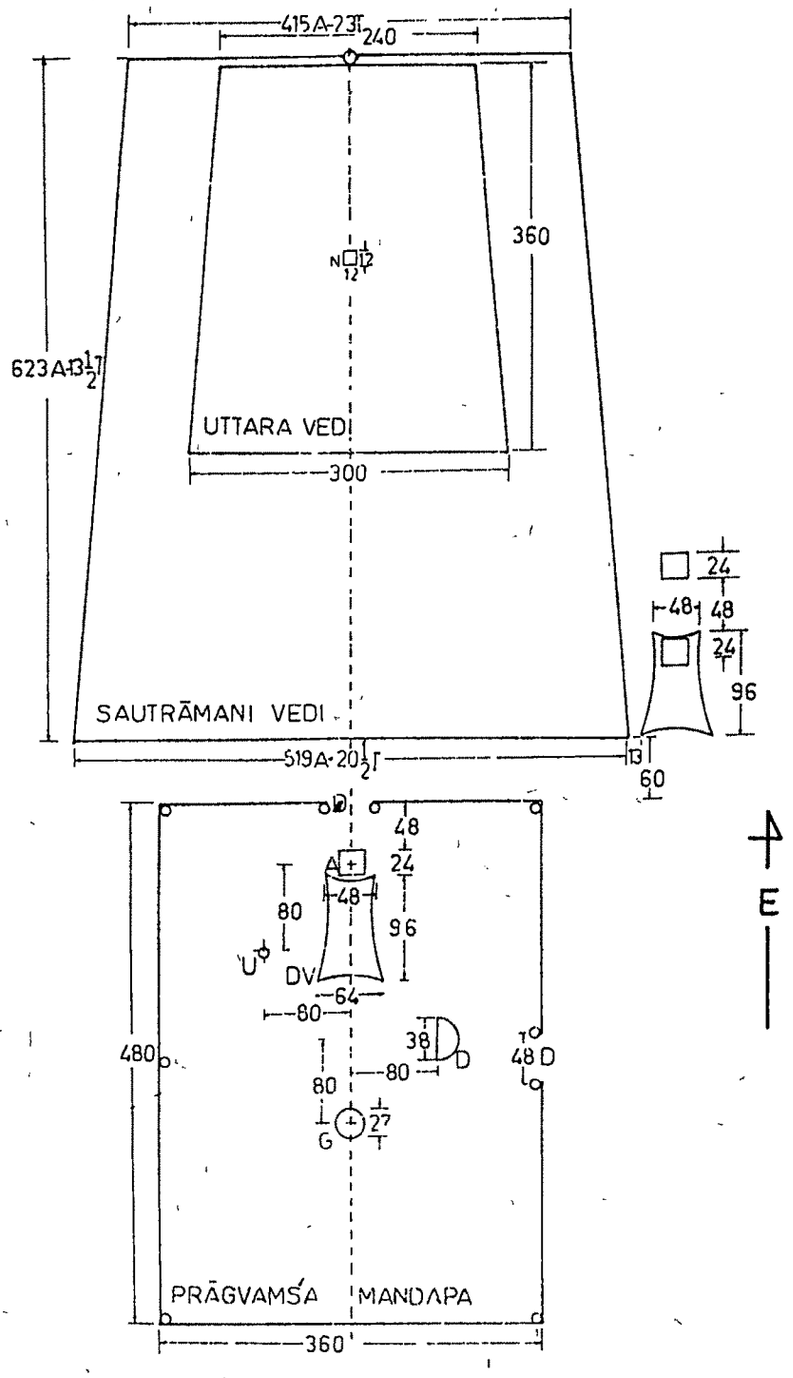
94 Ā Śr S 6 12-14

95 बाह्यछिद्रसहित षडसीत्यङ्गुलं युगम् । यावता वा बाह्ये धिद्रे बाह्यछिद्रयोरन्तरालमशीत्यङ्गुलम् ॥ Sundarājīyavyākhyā, Ā Śr S 6 9

96 छद्रान्तराळपक्षे षोडशाङ्गुलाहीना पुरस्तात्तिरश्ची । उरत्नीभिर्वा पुरस्तात् । गतम् । Karavindīya vyākhyā on Ā Śr S 6 12-14

97 अरत्नीभिर्वा चतुर्भिः पश्चात् षड्भिः प्राची त्रिभिः पुरस्तात् । Ā Śr S 7 3-9

Indological Truths



SAUTRĀMANĪ SACRIFICE (B) Fig 36

(B) (Scale 0 24 mm = 1 Aṅg)

Indological Truths

According to the Bau Śu Sutra,[98] the altar should be square shaped with its corners directed towards the main directions The area of the altar should be 1/9 the that of the Mahāvedi since the area of the Mahāvedi is 97289 sq padas, the area of Paitrkivedi should therefore, be 108 sq padas lengths of sides of the altar should be 10 padas, 5 angulas and 31 tilas (i e 155 angulas) A roofless square shaped pandal should be constructed to accommadate the Paitrkivedi It should have a door at the north side[99]

4. The Sautrāmaṇi sacrifice and its vedi

One should commence the performance of the Sautrāmani after performing the New moon sacrifice or under one of the auspicious constellations Thus the altar and fire places are same as that of Darśapaurnamāsa sacrifices In addition following altars should be constructed.

The Sautrāmani altar should be located towards the east of the āhavanīya fire place The centre line of this altar should be on the extended centre line of the Dārśikīvedi The area of the altar should be one third that of the Mahāvedi used for the soma-sacrifice [100] The area of the Mahāvedi is 972 sq padas or sq prakramas The west side of the Mahāvedi is 30 padas or prakramas long, the east side being 24 padas long The distance between the east and west sides is 36 padas or prakramas The length of sides of the square shaped sautrāmani vedi should, therefore be 18 padas or prakramas [101] Thus the area of Sautrāmani sacrifice is 324 sq padas

According to B Śu S [102] the Sautrāmani vedi should be rectangular or trapezium shaped In case the altar of the shape of a trapezium should be prepared then the sides of the Mahāvedi which is trapezium in shape should be divided by 3 so that

98 ता वेद कृत्वा दर्शपूर्णमासवत् सन्तमनवर्जं प्रागुत्तरात्परिग्रहाकृत्वा परेण यूपावटवेश सञ्चरमवशिव्य वेद्यां उत्तरवेदि दशपदां सोमे करोति। Ā Śr S 7 7-10.

99 पूर्ववदाज्यान्यभिमन्त्र्याग्रेणाहवनीय यूपावट परिलिखति अर्धमन्तर्वेद्यर्धं बहिर्वेदि। Ā Śr S 7 9-6

100 अर्धमन्तर्वेदि अर्धं बर्हिर्वेदीति यूपावटविधानम्। Vrtti of Ramachandra

101 शम्यमात्री निरूढपशुबन्धस्योत्तरवेदिः। Ā Śr S 7 3-13

102 ऊर्ध्वप्रमाणामुत्तरवेदेर्जानुघ्नादि खातपासु परिमाणमेव। Vrtti of Ramachandra, same 2 4 5

Indological Truths

The Layout of the Sautrāmaṇi Sacrifices (B)

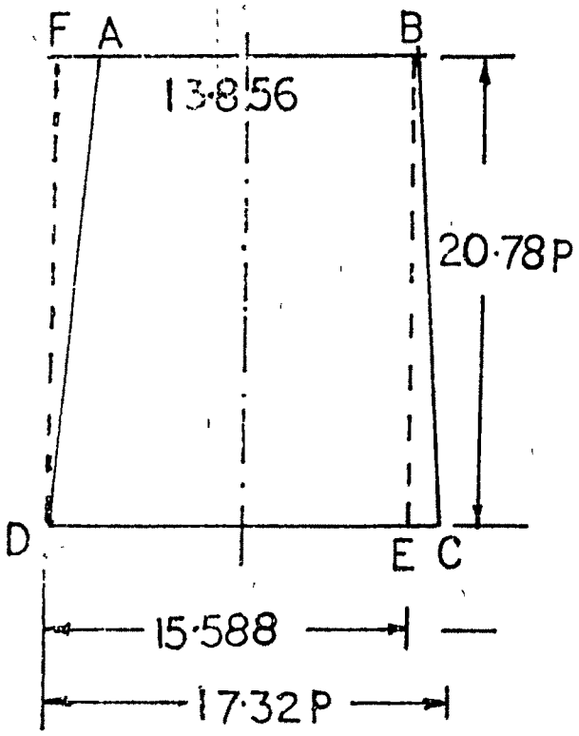


Fig 7.1

Different methods of giving layout of the Sautrāmaṇi Vedi

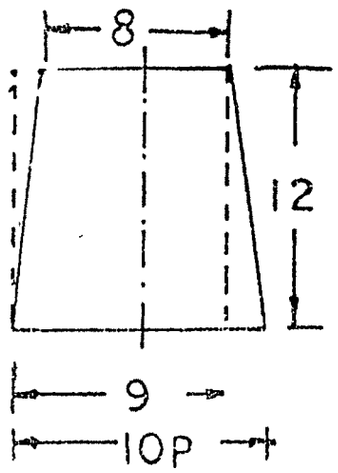


Fig 7.2

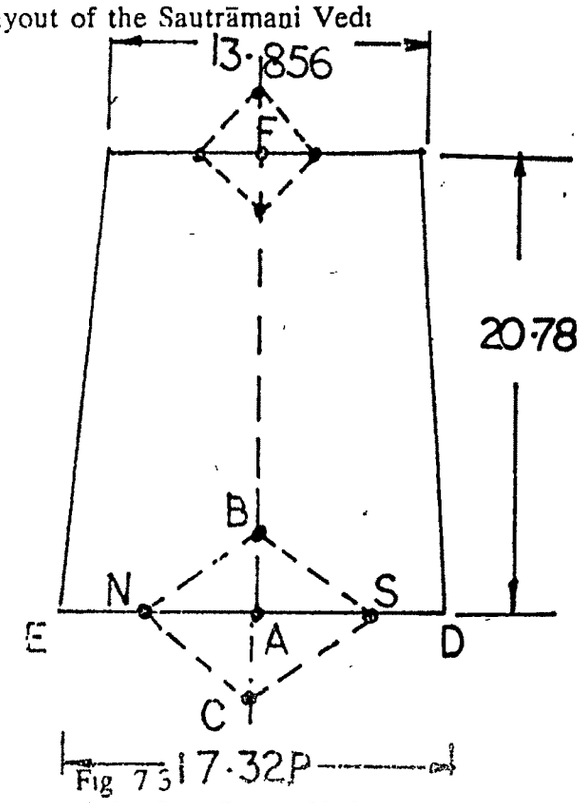


Fig 7.3

Different methods of giving layout of the Sautrāmaṇi Vedi

Fig 37

Indological Truths

the resulting trapezium would be of the area one third that of the Mahāvedi The length of the west side of the Sautrāmani vedi should be 30 / 3 = 17 32 prakramas length of the east side should be 24/ 3 = 13 856 prakramas and the distance between the east and the west sides should be 36/ 3 = 20 78 prakramas The area of the trapezium is 324 sq. prakramas (See the fig 36)

Dimensions of the Sautrāmaṇivedi:

ABCD is a trapezium having mentioned above and it is shown in the figure - 37 In order to draw a rectangle of the equivalent area of the given trapezium perpendicular BE is dropped on base DC Triangle BFC is lifted and placed such that line EC shall be in continuation of line BA and side BE shall be perpendicular to base D C Point C lies at F A rectangle of sides 15 588 prakramas and height 20 78 prakramas is obtained as in the figure - 37 [103]

Once the altar is prepared, the adhvaryu should construct the uttaravedi after taking earth from the cātvāla The procedure of preparation of the uttaravedi, location of the cātvāla etc should be similar to that of the uttaravedi etc of the animal sacrifice[104] The area of the uttaravedi should be one nineth that of the Mahāvedi In case the northern altar has trapezium shape then the dimensions of the uttaravedi should be east side 24/3 = 8 prakramas (240 angulas) west side 30/3 = 10 prakramas (300 angulas) and its length 36/3=12 prakramas [105]

If the shape of the altar should be rectangular then the dimensions of the uttaravedi should be east and west sides each nine prakramas long and length 12 prakramas The construction is explained in the figure - 37

A square shaped nabhi having sides 12 angula long and one angula in height should be constructed at the centre of the uttaravedi of either of the three shapes

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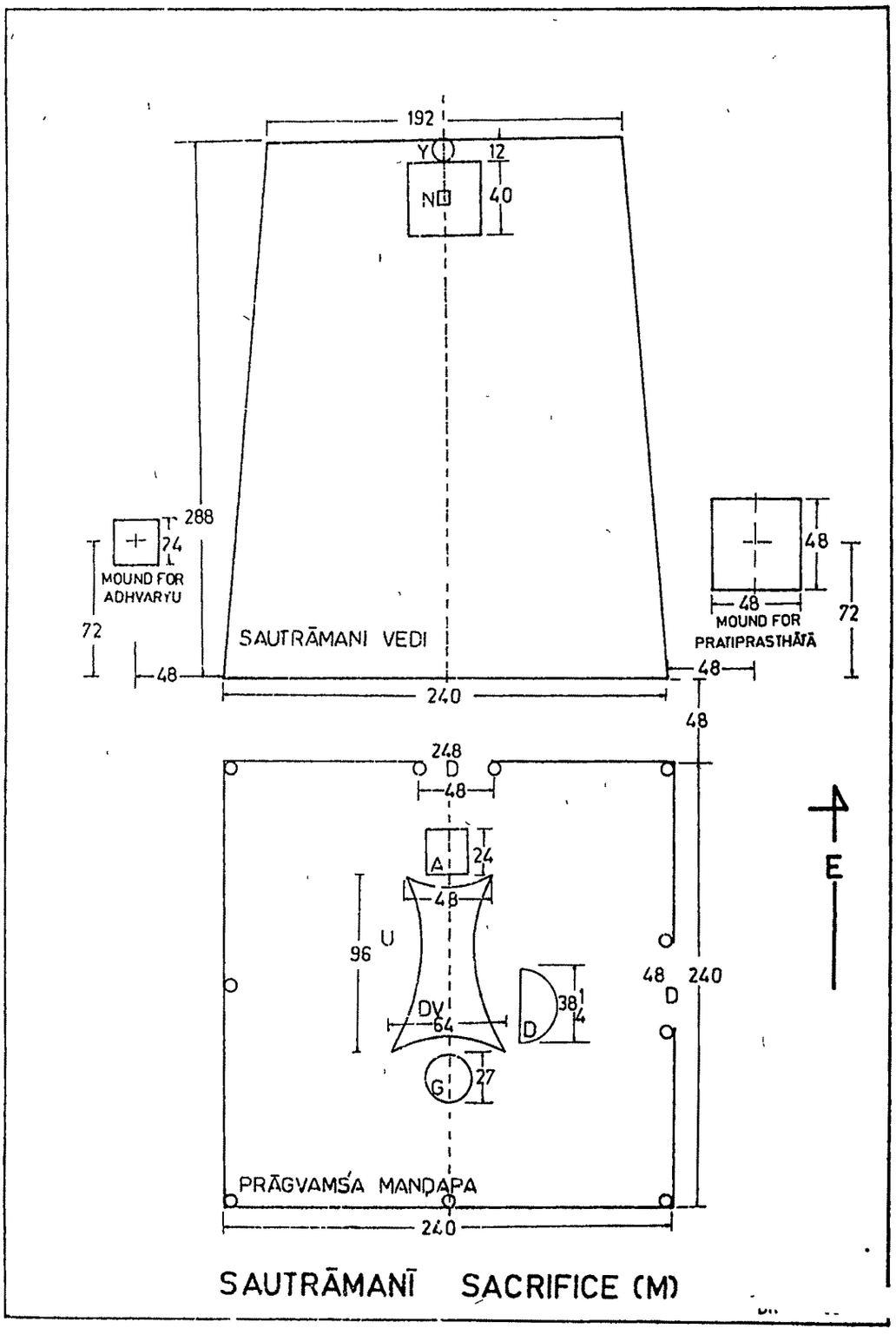
103 शोदमात्री अश्व एकमात्री वा उत्तरनाभिं चतुरस्रक्तिं कृत्वा । Ā Śr S 7 5 1

104 उत्तरस्माद्वेध सादुदक् प्रक्रमे चात्वालः । Ā Śr S 7 4 1

105 तदेता चतुरश्रा वेदिमलिखत्येव न खनाति । तस्यै मध्यतोऽन्वाहार्य । पचनमुपसमाधाय स्तम्बयजुर्हरति ।। B Sr S 5 11

Indological Truths

The Layout of the Sautrāmaṇi Sacrifices (M)



(M) Sautrāmaṇī Sacrifice (Scale 0.24 mm = 1 Anp)

Fig 38

Indological Truths

described above The B Ś S does not mention an altar or a mound meant for the sacred fire for pratiprpasthātr, although it is mentioned that he should carry for two portions of the fire from the daksināgni as the adhvaryu is taking out from that of the āhavanīya fire [106] It is suggested that an altar similar to the Darśikivedi may be prepared as described for the varuna praghāsa-parvan Accordingly, it is shown in the drawing (See fig - 38)

Layout of the Sautrāmaṇi Altar:

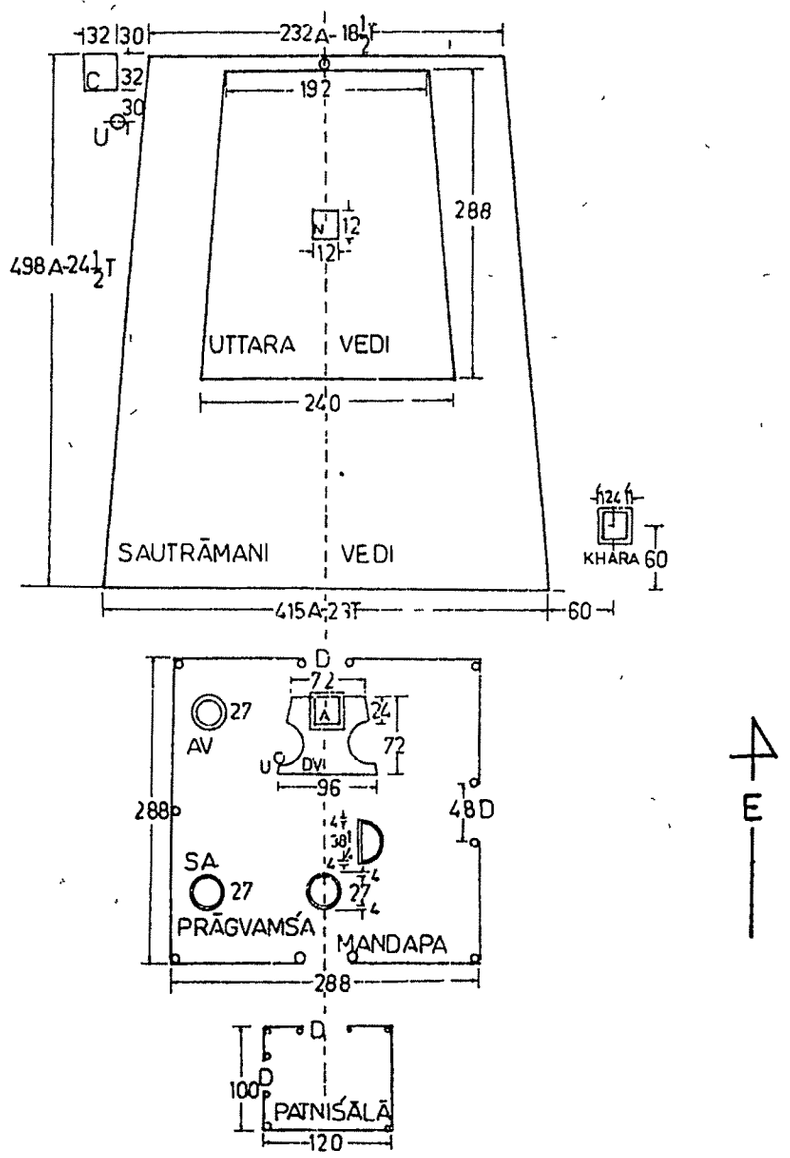
The layout of the altar and for the New moon and the Full moon sacrifices is already described

From the east side of the fire hall, along the extended prsṭhyā at a distance of 60 angulas, towards the east, fix peg A This gives the centre of the west side of the Sautrāmani vedi Take a cord 1732 prakramas long and joining its two ends obtain its mid-point Fix two pegs B and C at equal distance from (100 angulas) from peg A along the prsṭhyā one towards the east and the other towards the west of peg A Eastern two ends of the cord to peg B and C and holding the mid point of the cord in the hand stretch it towards the south and make a mark S where mid-point of the cord is located on the ground Repeat the construction towards the north and put a mark N on the ground Repeat the construction towards the north and put a mark N on the ground Remove ends of the cord from pegs B and C and spread it along NAS so that it mid point is at peg A as in the figure - 37 Fix pegs D and E where the ends of the cord are located Thus the western side of the altar is drawn

Fix peg F at the distance of 20 78 prakramas towards the east along the centre line from peg A This is the mid point of the eastern side Take a cord 13 856 prakramas long and repeating the procedure described to draw the western side, draw the eastern side perpendicular to the prsthyā and of the length of 13 856 prakramas Join pegs at four corners of the altar by a cord Check the accuracy of the layout by

106 वैचै करण इति। उपनिष्क्रम्याऽ राद्दक्षिणे पूर्वे वाऽवन्तरदेशे कुर्यादिति बौधायनः। अन्तरवैता दिशामिति शालीकिः ॥ अन्वाहार्यपचनमेवाऽभित इत्यौपमन्यवः ॥ B Śr S 21 4

Indological Truths

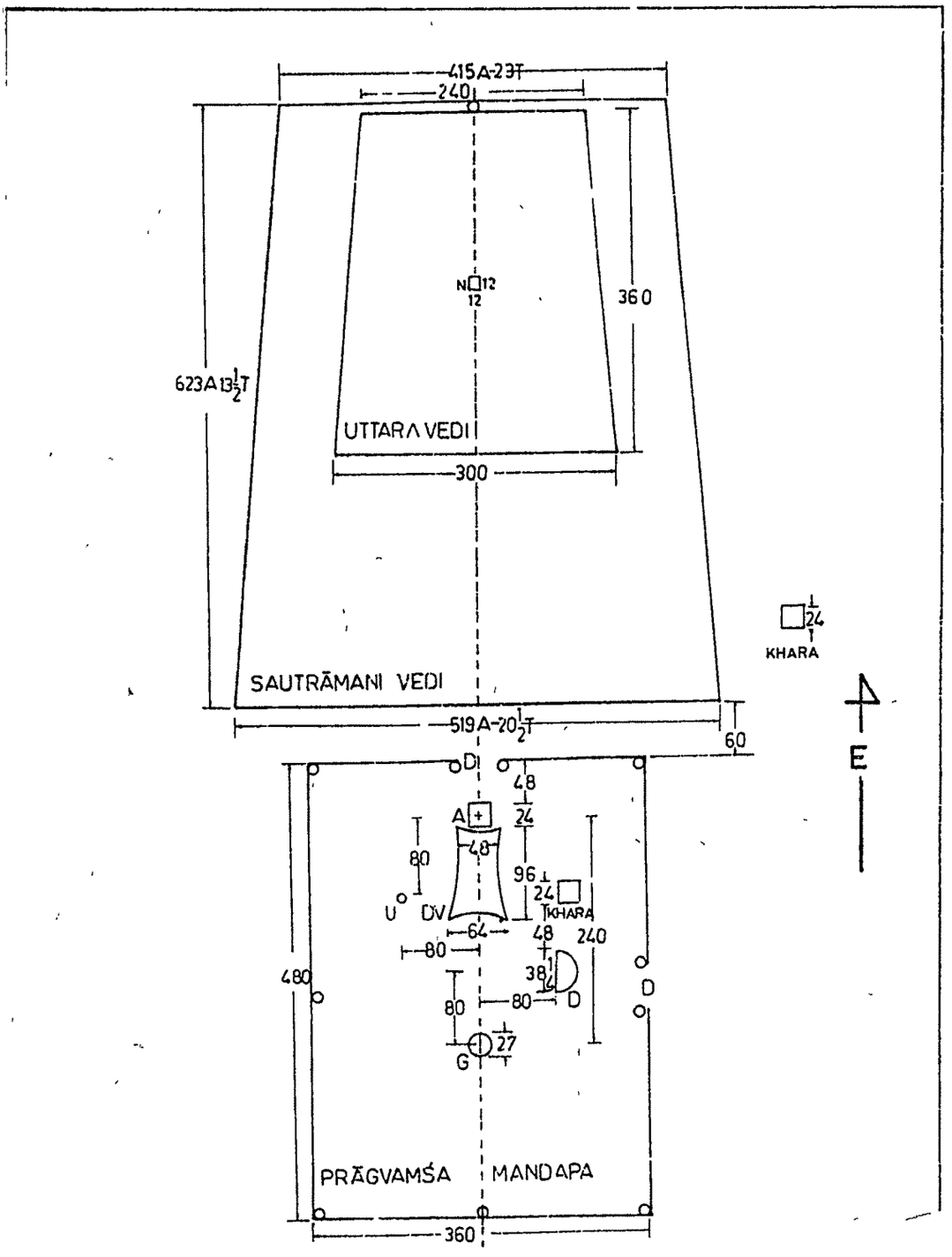


(K) Sautrāmanī Sacrifice (Scale 0.24 mm = 1 Aṅg)

Fig 39

Indological Truths

Layout for Different Sacrifices



SAUTRĀMAṆĪ SACRIFICE (Ā)

(Ā) Sautrāmaṇi Sacrifice (Scale 0.24 mm = 1 Aṅg)

Fig 40

Indological Truths

measuring length[107] of its diagonals which should be equal The diagram as shown in the figure - 37

Āpastamba and Mānava constructed Sautrāmanikı vedı with $^1/_3$ of the units used in Mahāvedı or 83 and 10 3 as face and base and 12 3 as latitude Manava followed the method suggested by Baudhāyana The Mahāvedı is an isosceles trapezium having face 24, base 30 and latitude 36 units Hence the Sautrāmanikı vedı[108] is an isosceles trapezium of face $^{24}/_{\sqrt{3}}$ or $^{30}/_{\sqrt{3}}$ base $^{30}/_{\sqrt{3}}$ or 10 3 and altitude $^{36}/_{\sqrt{3}}$ or 12 3 Hence the area comes out as 324 sq prakramas which is equal to $^1/_3$ of area of Mahāvedı

The method of determining the prakramas measure to be used for the layout of the altar in proportion to that used for the layout of the Mahāvedı, by Katyāyana is as given below [109]

Draw a square of the area equal to that of the Mahāvedı The area of the Mahāvedı is 972 prakramas The length of the sides of the square is 31 18 prakramas Divide four sides of the square into three parts of equal length, that is 10 39 prakramas. The square is thus divided in to line squares of equal area Draw a square, are of which is equal to sum of the areas of such small three squares the length of the sides of this square is 324=18 *prakramas* 432 angulas Give the layout of *Sautrāmanivedı* with this length of the *prakrama* measure

Sautrāamnikıvedı of Āpastamba and Kātyāyana is also in the same way as shown in the figures - 39 & 40

From the above mentioned method of construction we may find some geometrical operations

1 To find the area of square or trapezium and to get the square or trapezium of one third of its previous one

2 To construct a nine squares of equal area

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107 B Śr S 1 81-82

108 उत्तरत उपविशतो व्रहता च यजमानश्च दक्षिणतोऽध्वर्युश्चाग्नीध्रश्च अथैनत् परिप्रयन्ति ।। तस्योदीची द्वार कुर्वन्ति ।। B Śr S 5 13

Indological Truths

The Layout of the Cāturmāsya Sacrifices

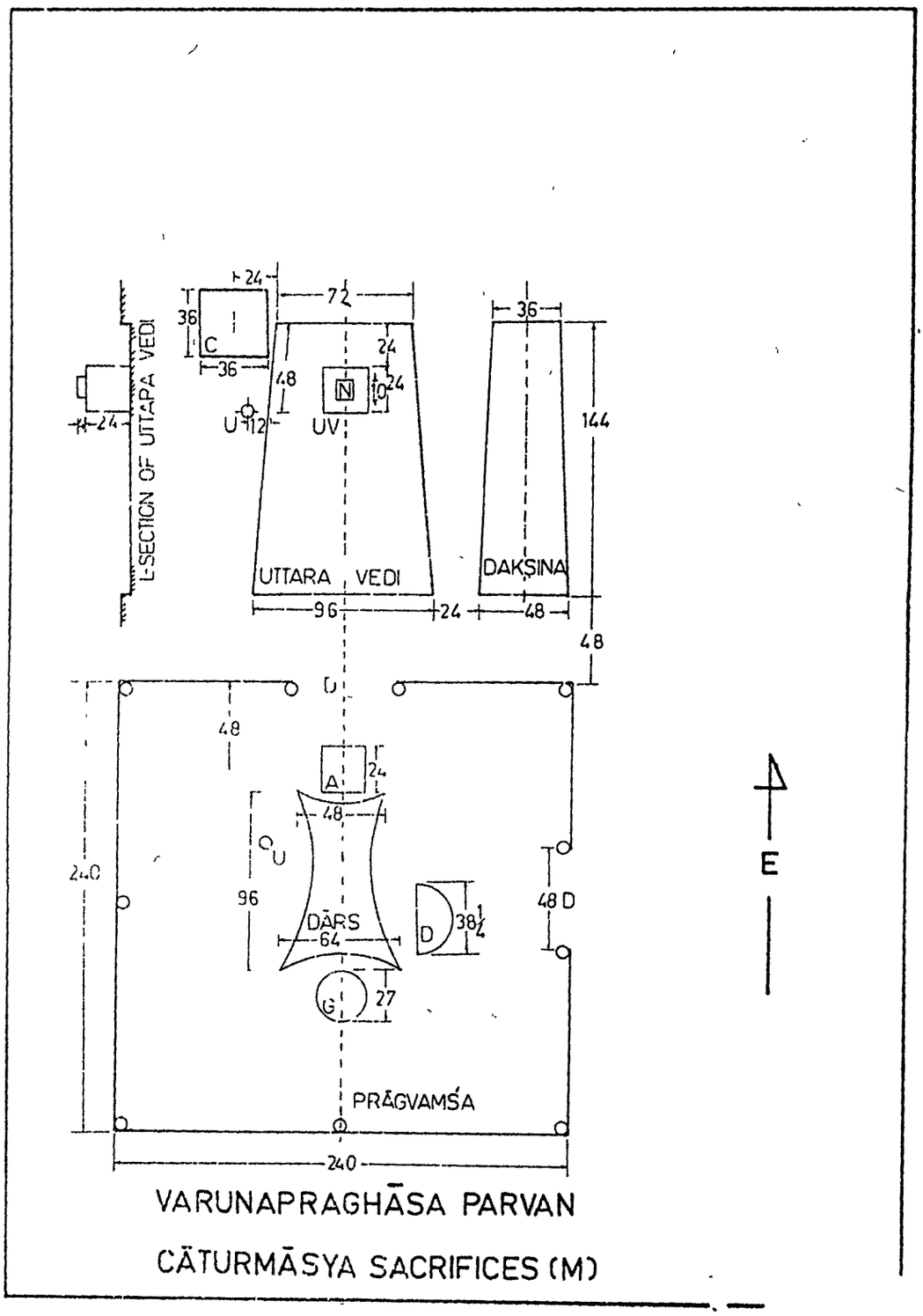
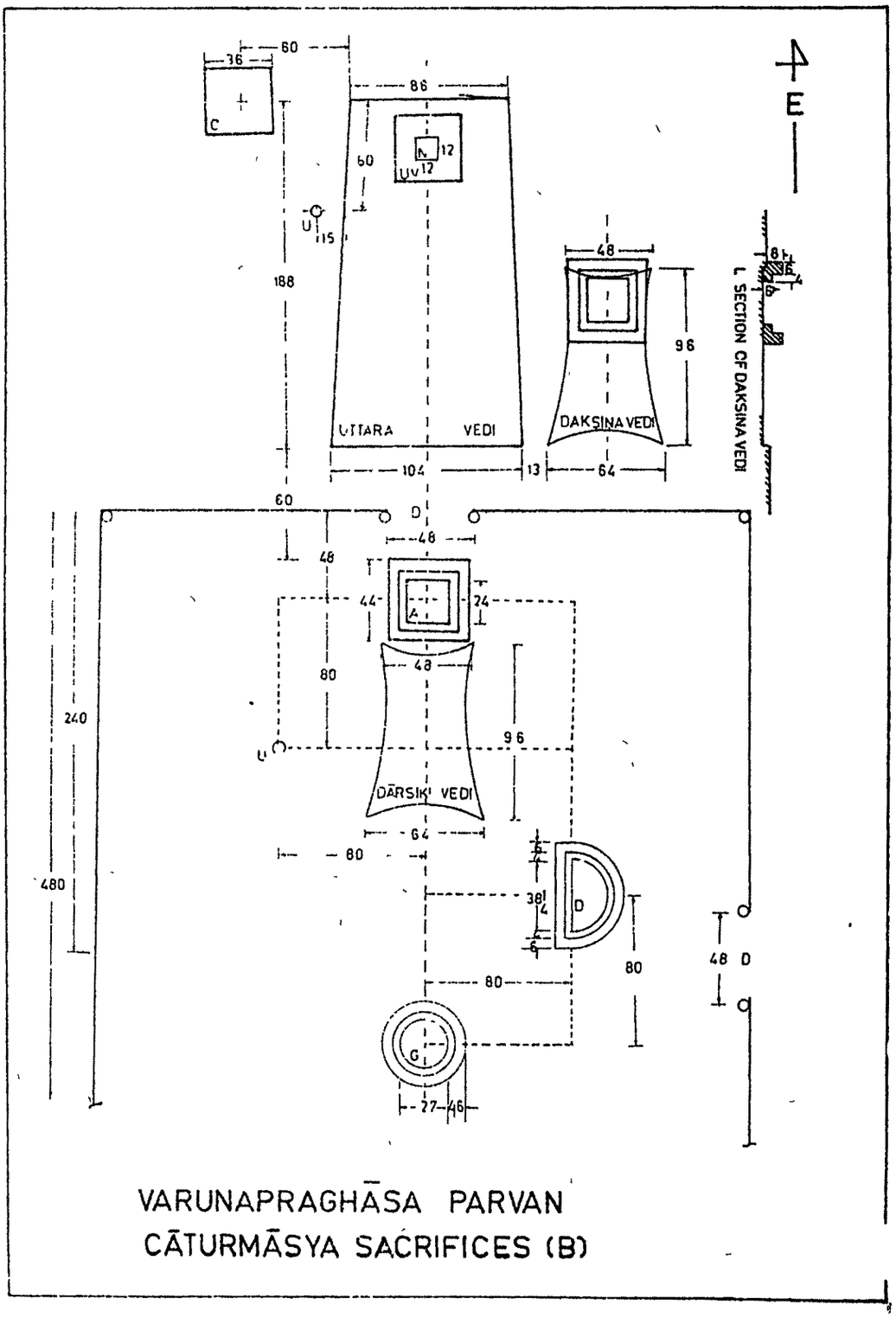


Fig 41

(M) Cāturmāsya Sacrifices
(Scale 0.24 mm = 1 Aṅg)

Indological Truths

The Layout of Cāturmāsya Sacrifices (B)



(B) (Scale 0.24 mm = 1 Aṅg)

Fig 41

Indological Truths

3 Accuracy of measurement of the geometrical figures

5. Cāturmāsya sacrifice:

Cāturmāsya sacrifices consist of the *Vaiśvadeva, Varuna praghāsa, Śākamedha* and *Śunāsīrīyaparvas* Parvan means a 'part' or 'joint' They are called cāturmāsyas because each of them take place after four months (चतुर्मास) They are performed respectively on the Full moon days of *phālguna* (or *caitra*) of *Āsādha, Kārtika* and on the fifth full moon day from the day on which the Śākamedha is performed

The Vaiśvadeva -parvan:

It is performed respectively on Caitra Full moon The layout of the fire places, the altar, cātvala, utkara etc should be similar to that of the New moon and Full moon sacrifices

In Baudhāyana śrautasūtra[109] 'vaiśya' is mentioned But they do not give the information on this term Śrauta padārtha Nirvacanam (SPN),[110] while describing altars and fire places accommodated in the fire hall, required for the performance of the Agniṣṭoma sacrifice, mentions that the space between the western border of the Dārśiki vedi and the eastern one of the gārhapatya fire place is called viśaya

The Varuṇa praghāsa -parvan:

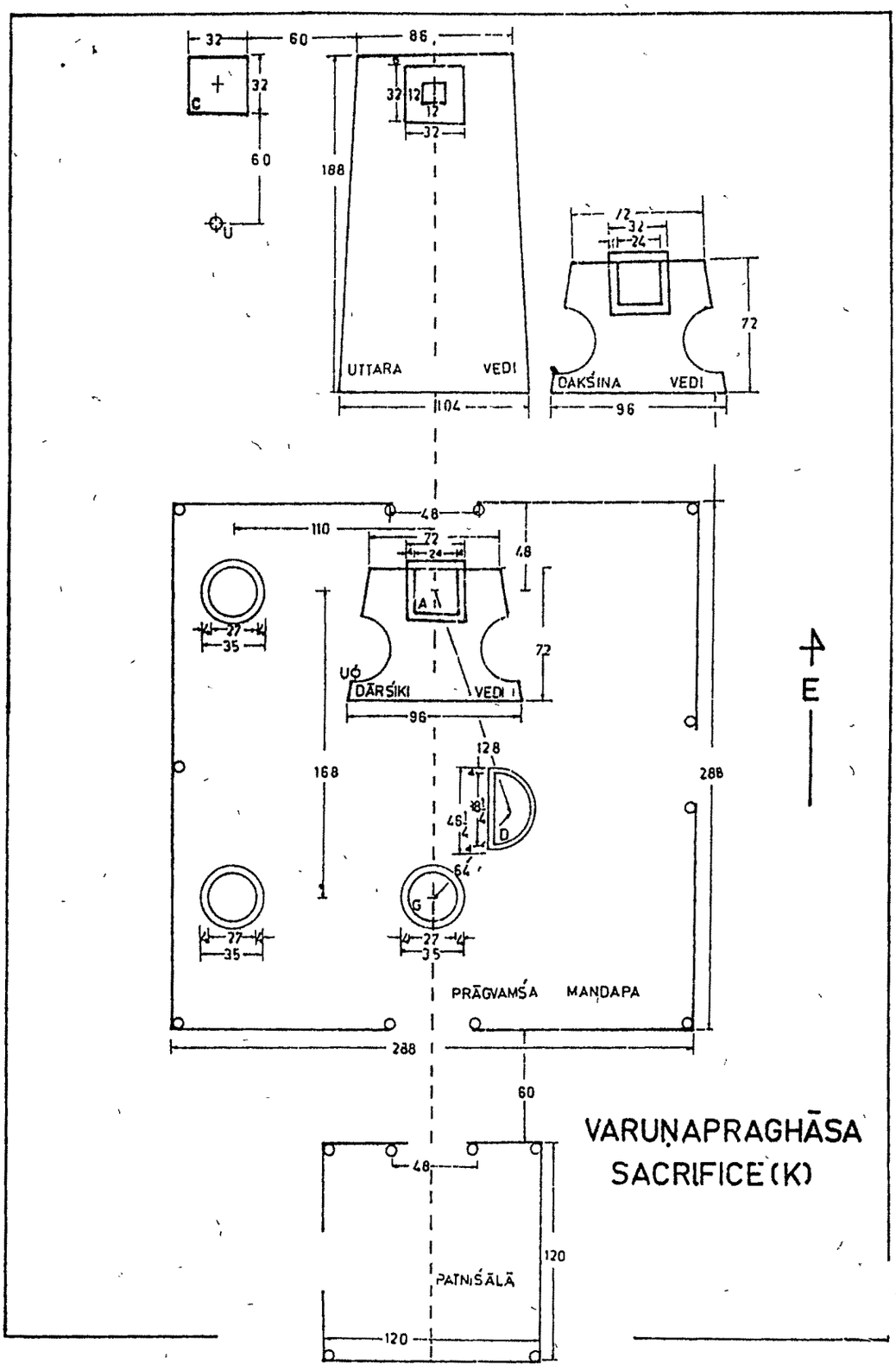
The layout of altars, fire places etc of this parvan is similar to that of animal sacrifice including the viśaya In addition to the Pāśuki or the Uttaravedi as it is called now, there should be another altar located towards the south of the Uttaravedi It is called the daksinavedi The daksinavedi should be similar to the darsinkivedi On its eastern portion, a fire place similar to the ahavanīya fire place should be constructed

The western sides of the Uttara and the daksinavedis should be in one line Where as their eastern sides should not Distance between the south west corner of

109 K Ś S 216-19

110 महावेदेस्तृतीयेन समचतुरस्रकृताया अष्टादशपदा पार्श्वमानी भवति ॥ B Śr S 5 1 86

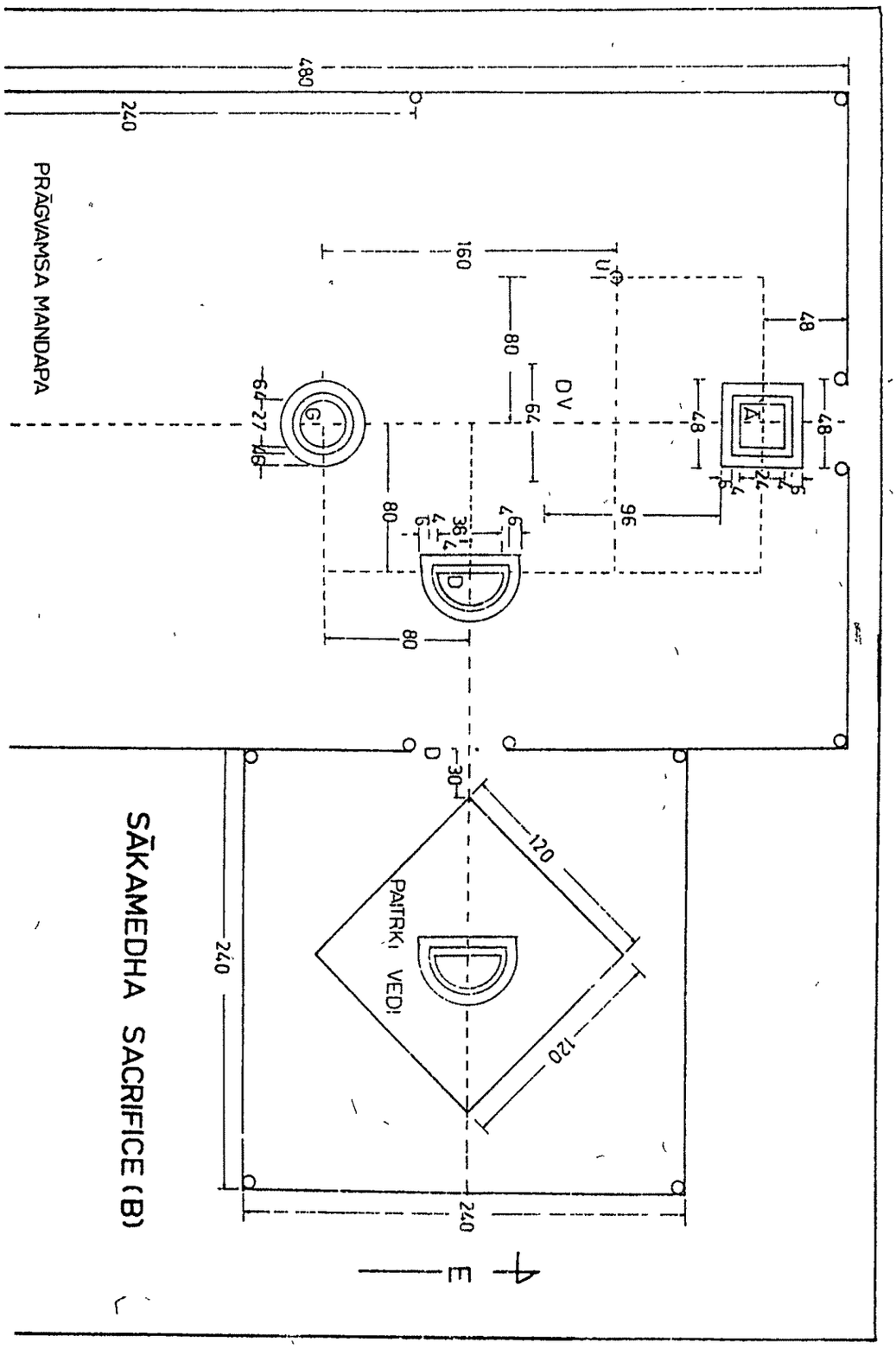
Indological Truths



(K) Varuṇapraghāsa Sacrifice
(Scale 0.24 mm = 1 Ang)

Fig 42

Indological Truths



(Scale 0.24 mm = 1 Ang)

Fig 43

Indological Truths

the daksinavedi should be one pritha[111] (13 angulas) As the uttaravedi like sthandila is not required to be prepared for the daksinavedi [112] a cātvāla is not necessary The utkara for the uttaravedi also serves as the utkara for the daksinavedi It seems that all the three vedis namely, the Dārśiki, the uttara and the daksina, are formed by digging the ground as given in the B Ś S

It also states that the nābhi on the uttaravedi should not be constructed if the Pāśukīvedi has the dimensions like that of a chariot, but in use of the uttaravedi of the Varuna-praghāsa parvan, even if its dimensions are like that of a chariot, a square shaped nābhi having sides one prādeśa long, should be prepared on it [113]

Layout of Altars:

As the procedure for the laying out of the pāśukī and Dārśikivedis has been already described in detail, further elaboration is not necessary The only care to be taken is that the east west centre line of the daksinavedi should be parallel to the prsthyā which is the centre line of the Pāśuki and daksinavedis The diagram of the layout is as shown in the figures - 41 & 42

The Śākamedha - Parvan:

The layout of fire place, daksinavedi etc should be similar to that prescribed for the New moon and the Full moon sacrifices as in the figures - 43 & 44

A paitrki vedi should be constructed for performing Mahapitryajña Towards the south, there should be prepared a level piece of ground The adhvaryu should trace out upon it a square altar He should not dig it up In the centre of the altar he should enkindle the anvāhāryapacana fire

Bodhayana says that one should go out of the fire-hall and prepare the altar in the south east Śaliki says that one should prepare it in the south east but neither the

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111 त्रिंशत्पदानि प्रक्रमा वा पश्चात् तिरश्ची भवति षट्त्रिंशत् प्राची, चतुर्विंशति पुरस्तातिरश्चीति महावेदेर्विज्ञायते । B Śr S 1 90

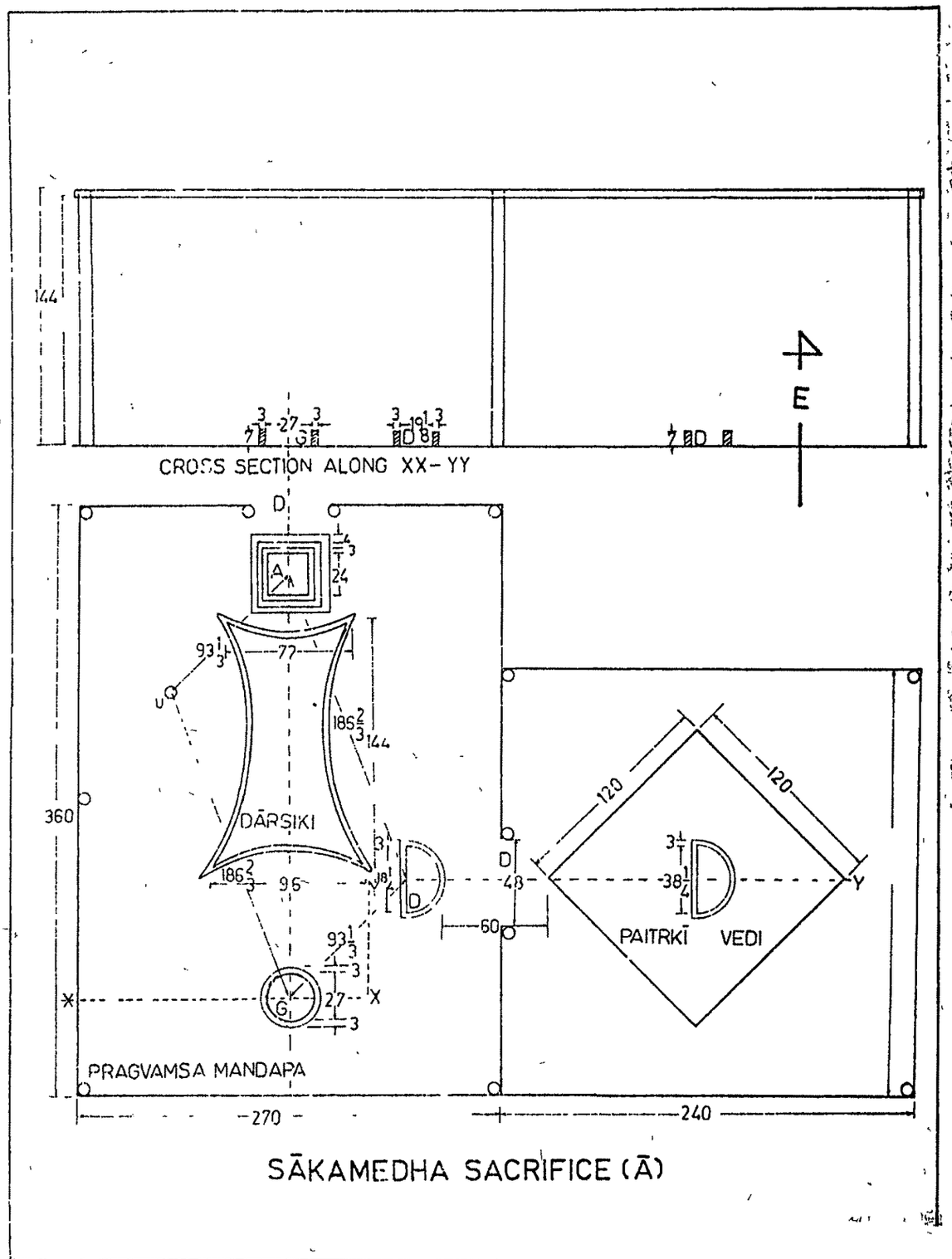
112 B Śr S 1 87

113 B Śr S 1 55

Indological Truths

100

The Layout of Cāturmāsya Sacrifices



(Ā) Sākamedha Parvan Cāturmāsya Sacrifice
(Scale 0 24 mm = 1 Ang)

Fig 44

Indological Truths

fire hall itself Aupamanya says that one should prepare it round the anvāhārya pacana fire [114]

According to BŚ S [115] the altar should be square shaped with its corners directed towards the main directions The area of the altar should be 1/9th that of the Mahāvedi [116] The lengths of the sides of the Mahāvedi are already mentioned and area is 972 sq padas Therefore the area of the Paitrkivedi should be 108 sq padas or prakramas The layout of the sākamedha parvan is shown in the figure east west centre of the daksinavedi

Varuni and Marutivedis:

Manava, named the northern altar of Varuna preghasa parvan as Vāruni and the southern altar Māruti

The northern altar i e Vārunivedi should be dug up two or four angulas deep below the ground level In the eastern half of the altar, baring out the eastern one-third portion, a square shaped uttaravedi (i e a sthaṇḍila) should be constructed It should have sides one aratni long and its height should be again one aratni The eastern side of the uttaravedi should be distance of 24 angulas from the eastern side of the altar The east-west centre line of the uttaravedi and that of the altar should be coincident A nābhi should be constructed at the centre of the uttaravedi It is square shaped having its sides one prādeśa long Its height is presumed to be four angulas or one angula Earth for the construction of the uttaravedi and the nābhi should be taken from the cātvāla The vedi is bright ened by pouring sand over it [117]

The southern altar i e Mārutivedi should be located such that the distance between its north-west corner and south west corner of the uttaravedi is one aratni

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114 उद्धन्ति । उद्धतादाग्नीध्रस्त्रिर्हरति । यदाग्नीध्रस्त्रिर्हरत्यथ चात्वालस्यावृता चात्वाल परिलिखति । उत्तरवेदेरावृतोत्तरवेदि त्रिवपति । उत्तरनाभिमुत्साद्य यूपावट खत्वा ।। B Śr S 1 7 33

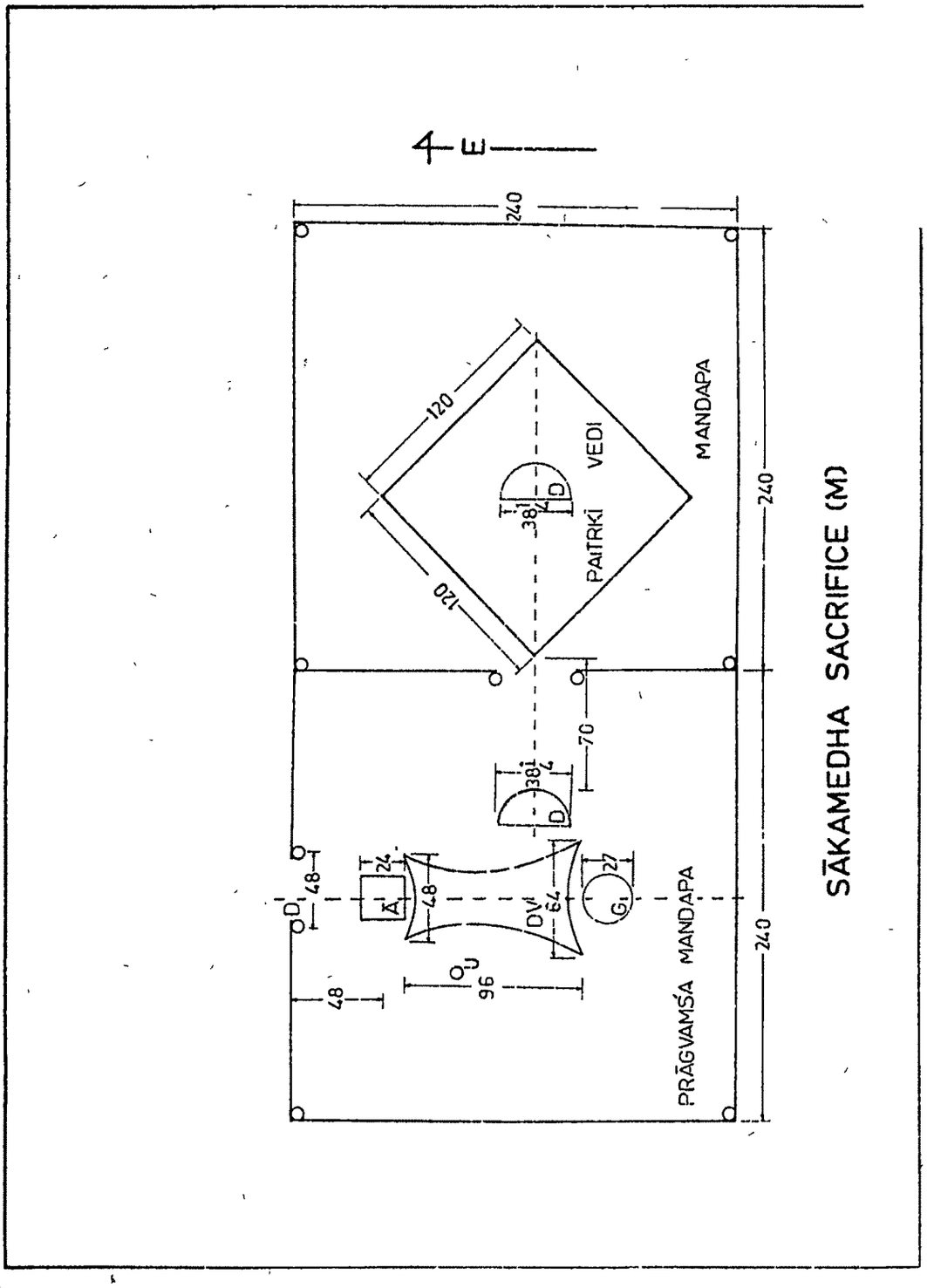
115 B Śr S 1 85 (वेदीतृतीये यजेतेति सौत्राणिकी वेदिमभ्युपदिति ।।

116 अग्नेरावृता द्वावग्नीप्रणयत आहवनीयादेवाध्वयुरन्वाहार्य पचनात् प्रतिप्रस्थाता ।। B Śr S 17 33

117 B Śr S 1-36-40

Indological Truths

Layout for Different Sacrifices



(M) Sākamedha Sacrifice (Scale 0 24 mm = 1 Ang)

Fig 45

Indological Truths

The east west centre line of the daksinavedi should be equal to that of the uttaravedi west sides of both the altar should be in oneline The length of the daksinavedi should be equal to that of the uttaravedi i e 144 angulas. The daksinavedi should be broad enough to accommodate oblations Depth of the daksinavedi, below the ground level, should be two or four angulas like that of the uttaravedi Dimensions of the daksinavedi are length of the west side two aratnis length of the east side 1-11/2 aratnis and the distance between the east and the west sides six aratnis The procedure of the layout of both the altar with modern mathematical interpretations are given below (See the figure - 45)

A cord, 12 aratnis long, is divided in two parts One being $4^1/_2$ aratnis and another $7^1/_2$ aratnis Number of marks are put on the cord as shown in fig From the eastern side of the āhavanīya fire-place measure a distance of three prakramas (72 angulas), towards the east, along the prsthyā and fix peg L1 Measure a distance of six aratnis towards the east along the prsthyā and fix peg Z1 prsthyā[118] Fasten ends of the cord Z1 and L1 and stretch it towards the south by holding it at the mark N Fix peg N1 where the mark N is located on the ground Repeat the procedure by reversing ends of the cord to pegs Z1 and L1 and stretch it towards the south by holding it at the mark N Fix peg H where the mark N is located This is the south-west corner of the daksinavedi Now place the cord along L1H so that the mark P on the cord is at L1 and the mark G is towards the north of it Fix peg G1 where the mark G is located This is the north-west corner of the uttaravedi Fix peg N11 where the mark N on the cord is located This is the south-west corner of the uttaravedi Fix peg N11 where the mark N on the cord is located This is the south-west corner of the uttaravedi Fix peg C1 at the location of the mark C This is the western mid point of the daksinavedi The distance between pegs C1 and H is one aratnis Measure this distance towards north, along the cord from peg C1 and fix peg M which is the north-west corner of the daksinavedi Thus the corner points on western sides of both altars are obtained The distance between pegs N1 and M is 1/2 aratnis

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118 Ā Śr S 5-8-10

Indological Truths

Spread the cord along Z1 and N1 such That point Z on the cord lies on peg Z1 and the endmark K on the cord is towards the north Mark T on the cord lies at a distance of 1-1/2 aratnis from mark Z1 Fix peg T1 at this point This is the north-east corner of the uttaravedi Fix peg J1 where mark K J lies on the ground This is the south-east corner of the uttaravedi Fix peg C11 where the mark C on the cord is located This is the mid-point of the eastern side of the daksinavedi Measure the distance of 3/4 aratni along the cord, on both sides of peg C11 and fix pegs F and E which give the north-east and south-east corners of the daksinavedi respectively Thus both the northern and the southern altars are laidout

The āhavanīya fire place should be constructed on the southern altar The distance between the eastern side of the āhavanīya fire place and the eastern border of the altar should be 24 angulas

The Cātvāla and the Utkara:

The cātvāla should be located at the distance of one prakrama, towards the north, from the north-east corner of the northern altar[119] It is square shaped, its sides being one Śamyā long Its elepth should be one jānu Its sides should be vertical [120]

Location of the utkara is not given in M Ś S But it may be located at a distance of four padas (48 angulas) from the north-cast corner of the northern altar and one pada towards the north [121] There only one utkara for both altars [122]

Conclusion

The construction of various vedis involve a clear layouts like structuar designs

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119 K Ś S 2-11-12

120 अथ एतानि सपरिमृह्यान्तर्वेद्यासादयति भुर्भुवः सुवरित्येताभिर्व्याहृतीभिरुत्करे वा विषये वा वाजिनम् । B Śr S 5 2

121 आहवनीयस्य पश्चात्प्राकृतवेदिः । तत्पश्चादवशिष्टो विषयः ॥ S P N 15/188

122 द्वे वेदी । तयोः पशुबन्धिकीवोत्तरा दार्शपौर्णमासिकीव दक्षिणा । ते पश्चात्समे पुरस्ताद् विषमे पथमात्राद्वेदी असम्भिन्ने भवतो । B Śr S 5 5

Indological Truths

of building foundation As engineers design the picture of the 'plan' in a systematic way with all measurements In the same way, Śulbasūtrakaras or Śrautasūtrakaras, designed the various vedis with all measurements The modern engineer's used the compass or other mathematical scales and pencils for the 'plan' of a building But śulbasūtrakārs used only cord and peg for marking this Now white sheet is used for designing a 'plan' while Śulbasūtrakāras designed the vedis in a sacrificial ground which they choose But one thing is very sure that the layouts of fire places and altars involves systematic technical proceedures and measurements, even though their purpose of doing this only for the performing the Nitya and Kāmya sacrifices

□

Indological Truths

Chapter - 5

Citis in Šulba Sūtras : A Technical Analysis

चिति (Citi) is a platform constructed of burnt bricks and mortar It is a raised altar, generally made up of bricks, for keeping the fire[1]- *Citis* (or the fire-altars) The fire-altars were of two types- the *nitya* (or perpetual) and the kāmya (or optional) The three perpetual fire-altars were the gārhapatya, the āhavanīya and daksināgni and meant for daily sacrifices The kāmya citis intended for wish fulfilment, included the *śyenacit*, the *vakrapaksa-vyasta-puccha-śyena*, the *kankacit*, the alajacit, the praugacit, the ubhayata praugacit, the dronacit, the rathacakracit, the śmaśānacit, the kūrmacit and so on[2] Thus these platforms are of different shapes These citis invoke highly complicated technical and geometrical operations It is also required accurate construction to achieve the special objects Each of these citis shall have the same-areas as that of the standard form of the śyena-cit, i e $7^1/_2$ sq purusa Thus eventhough the shapes of various citis are different, their area is the same i e $7^1/_2$ sq purusa The details of the geometrical knowledge developed for the construction of these citis are given in different śulbasūtras All types of citis described in different śulbasūtras are tabulated in the Appendix

Bricks :

The fire-altar (*citi*) is constructed with the different shapes of brick Therefore it is quite clear that, the fabrication of bricks was known at the time of śulbasūtrakāras, even before the time of Brāhmanas I have listed the different types of bricks which were used for construction of altars is given in a separate table in the Appendix

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1 चितेऽग्नावुत्तिष्ठतो नाग्निचित्या साचितिर्भवति । – ĀŚr S XVI 35

2 एतया विकृत्याऽभिमन्त्र्यान्या चिति चिन्वन्ति द्रोणचित वा रथचक्रचित वाकङ्कचित वा प्रउगचित वोभयतः प्रउग वा समुह्यपुरीष वा न तथा कुर्याद्यथा पक्षपुच्छवन्त गर्भं परिवृश्चेत्तादृक् तत् तस्मादेनसुपर्णचितमेव चिनुयात् ।
– Ś Br VI 7 2 8

Indological Truths

Fabrication of Bricks :

A detailed description of stabilising of soil to be used for making and also the procedure of their burning is given in the Śatapatha Brāhmana The earth dug out from the nearly ground, meant for the sacrificial ceremony, is stabilised by adding in it gum extracted from Palāśa tree It is added in such a quantity in water that when stirred vigorously foam is formed in it In the soil, rock flour, hair of goat, of a bullock and of a horse are added The water with gum is added to the soil so as to form lumps of soil of putty like consistency It is mentioned that the above mentioned materials are added to the soil so as to increase its strength [3]

Two additional methods of soil stabilisation are given in Baudhāyana śulba-sūtra Bricks required for construction of a citi which is to be used for a month (or for a year), may be prepared from soil in which ash from Ukhā is added It is specifically mentioned that ash from ukhā need not be added in soil for bricks which are to be used only for one night Further it is specifically mentioned that such bricks are stronger than those to which ash is not added [4] This very method of soil stabilisation is used again in the twentieth century Now the bricks used for building are made of soil mixed with fly ash precisely for this reason

Another method of soil stabilisation is the use of surkhi The pot called ukhā is made of stabilised soil Then the ukhā pot is allowed to dry under the sun and the drying process is hastened by smoking it by burning horse-dung Then it is burnt in a clay It is mentioned that if this pot is found to be broken or that cracks are developed in it after the firing operation, then the pot is thoroughly powdered and mixed with the soil which is to be used for the preparation of the pot ukhā It is mentioned that a pot prepared of the mixture of soil and burnt clay, that is surkhi,

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3 पर्णकषायनिष्पक्काऽएताऽआपो भवन्ति । स्थॅग्नेन्वेव । 6 5 1 1 ताऽ उपसृजति ॥ 6 5 1 2, अथ फेन जनयित्वान्ववदधाति ॥ 6 5 1 3, अथाजलोमैः ससृजति । स्थेग्नेन्वेव 116 5 1 4, अथैतत् त्रयपिष्ठ भवति । शर्कराऽश्मापोरस्तेन संसृजति स्थेग्ने न्वेव यद्वेव तेनैतावती वाऽश्यमग्रेऽसृज्यत तद्यावतीमग्रेऽसृज्यत तावतीमेवैनामेतत्करोति ॥ Ś Br 6 5 1 6

4 B Ś S 2 78-79

Indological Truths

is strong and never breaks It is well known now that surkhi acts as a puzzolana and helps increase the strength of the soil [5]

Bricks are to be fabricated in good numbers, more than thousand so that after rejecting the broken or deformed ones, the remaining bricks are of requied numbers, usually thousand Bricks of different sizes are also required to be fabricated It is therefore, obvious that bricks are manufactured by using moulds (karana) of required sizes The use of moulds is mentioned in śulbasūtras [6] It is thought that ash may be sprinkled on the inner sides of the mould so that bricks formed in the mould could be easily removed from it

The moulds may be prepared by fixing wooden planks with joints and strengthening them with wooden nails It is rather unlikely that moulds are prepared with hinges at one corner so that instead of dropping the bricks on the ground by giving strokes to the mould, one may remove the side of the mould smooth by opening it along the hinges There is no mention of hinges for brick moulds in any of the śulba-sūtras It is however, a point of conjuncture as in Ā ś s ,[7] it is mentioned that the sides of the mould are to be bent so as to form bricks to be placed at the centre of both the wings of a śyenaciti (paksamadhyīya bricks) But this may not mean that the sides of the mould are provided with hinges so that this angle between the sides may be more than 90 degrees as is required for the particular brick

Mānasaśulbasūtra states[8] that the size of the mould should be somewhat more than required, so that the bricks formed of wet stabilised soil after shrinking due to their drying under the sun and due to burning will be of the required dimensions He does not allow, like Bodhāyana, to use bricks of somewhat smaller dimensions due to above mentioned reasons and does not suggest to make a citi of the size and

5 यद्येषोसा भिद्येत ॥ 6648 अथ मृदमाहृत्य । उखा चोपशया च पिष्ट्वा संसृज्योखा करोत्येतयैवावृताऽनुपहरन्पक्त्वा पर्यावपति । – Ś Br 6649

6 B Ś S 489 M Ś S 10252 Āp Ś S 163

7 Ā S S 1913

8 M Ś S 251-3

Indological Truths

dimensions as required by adding wet soil in the joints wherever required [9] He further states that the decrease in the dimensions of a brick of 12 x 12 angulas Thus if one is to prepare a brick of 144 sq angulas area, he should design a mould of such dimensions that its area will be equal to 150 sq angulas This statement given in formation of brick (a) The dimensions of the bricks finally formed should be equal to the stated dimensions (b) If the soil used is such that its shrinkage is more, so that a brick of 150 sq anguals area may shrink to the size smaller than 144 sq angulas, then such soil is not properly stabilised as bricks made of such shrinkable soil are liable to develop cracks due to shrinking with loss of water because of drying under the sun and because of burning It, thus gives the norm regarding the shrinkability of the soil to be used for the fabrication of bricks Mānava further states that the dimensions of the bricks decrease by one-thirtieth [10]

The method of preparing bricks :

In Śatapatha Brāhmana[11] the method of preparing bricks is described The bricks are prepared by using moulds Then they are allowed to dry in the sun In order to hasten the drying process, they are subjected to smoking by burning horse dung Then a pit having four sides is dug Wood sticks and coal are placed in the pit along with the bricks They are covered by thick layer of wet mud and then fired After the fire is burnt out then the burnt bricks are taken out The method of burning bricks is very economical as it is closed furnace type

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9 B S S 2 60

10 M Ś S 4 17

11 तस्याऽएतस्या आषाढा पूर्वा करोति । इय वाऽग्रषाढयेषु वाऽएषां लोकाना प्रथमाऽसृज्यत तामेतस्याऽएव मृदः करोत्येषाह्येव लोकानामिय महिषी करोति । पादमात्री भवति । प्रतिष्ठा वै पादऽद्वयमु वै प्रतिष्ठा त्र्यालिखिता भवति । त्रिवृद्धीयम् ।। Ś Br 6 5 3 1-2

विश्वज्योतिषः करोत्येता एता देवता (अग्निं वायुमादित्यमेता ह्येव देवता अथैना धूपयति । स्थेम्ने न्वेवायो कर्मणः प्रकृततायै यद्वेव धूपयति । शिर एतद्यज्ञस्य यदुखा प्राणो धूमः । अश्वशकैर्धूपयति । प्राजापत्यो वाऽअश्वः प्रजापतिरग्निनो वाऽआत्माऽऽत्मानहिनस्त्यहिसायै तद्वै शक्रेव ।। Ś Br 6 5 3 8-9

Indological Truths

Specifications fo bricks :

Citi are constructed of bricks which are first dried in the sun and then burnt so as to be cindered and become hard

BŚS [12] gives clearly the specifications of bricks which are so essential in their character that even today they are followed scrupulously-

These specifications may be listed as follows-

i The broken bricks should not be used The brick broken into two or three brick bats of any irregular shape during handling is weak and therefore, should not be used The brick bat masonry A brick with broken edges also disfigures the masonry

ii A brick in which cracks are developed should not be used, as it is likely to break under the weight of the masonry

iii Old bricks should not be used Only newly fabricated bricks are to be used

iv A brick which is overburnt and consequently is black (or colour of copper) in colour should not be used, as it not only mars the colour scheme of the citi but is many times out of shape

v A brick with some marks either as depressions or with protruding mass should not be used as the brick will not seat snugly or much more wet soil will have to be applied to adjust such a brick in line with and keep it level with other bricks [13] Some of these specifications are given in Śatapatha Brāhmana[14] also

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12 B Ś S 2 52-2 56 (न खण्डानुपदध्यात् । न भिन्नमुपदध्यात् । न जीर्णमुपदध्यात् । न कृष्णामुपदध्यात् । न लक्ष्मणामुपदध्यात् ।)

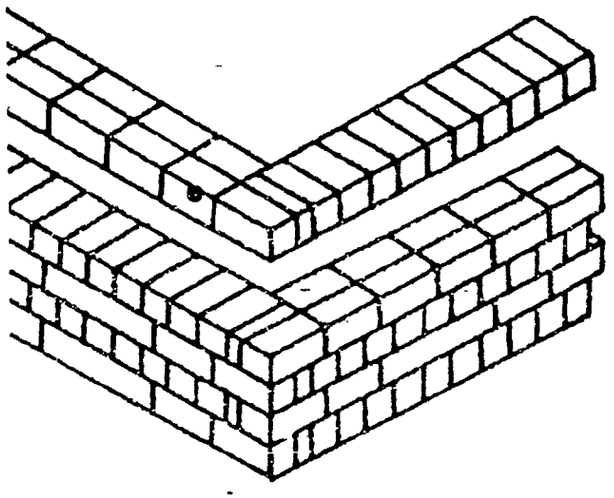
13 न भिन्ना न कृष्णामुपदध्यात् । आर्हति वाऽऽषा या भिद्यतऽआर्तम्वेतद्रूप यत्कृष्ण नदातमात्मानमभिसस्करवाऽइति । Ś Br 8 7 2-16

14 भेदान्वर्जयेत् । अधरोत्तरयोः पार्श्वसधानं भेदा इति उपदिशन्ति । तदन्यन्तेषु न विद्यते ।। न सक्तिपार्श्वयोः ।। B Ś S 2 22-25

Indological Truths

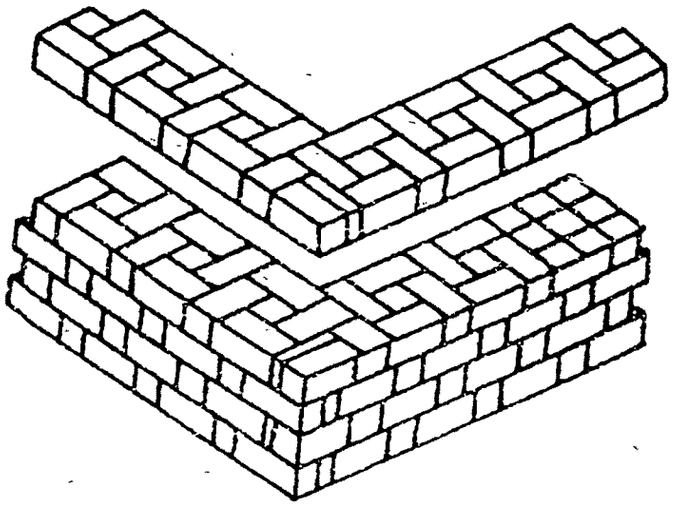
Methods of Arrangement of Bricks

(A Comparison)



English Method in Engg.

[" Upacāyya " method in Śulbasūtra]



Flemish Method

[" Paricāyya " according to Śulbasūtras]

Fig 45a

Indological Truths

vi The bricks should be made with accurate measurement They are very particular about their quality of the bricks

Specifications for the construction of Citi :

The specifiction regarding the construction of brick masonry given in BŚS are of essential nature and are followed even today, wherever mortar used is weaker than bricks

One of the important rule is that when bricks are placed one over the other then they are arranged in such a way that the joints in the layer of brick below and above will be broken by the joints in the layer of bricks in between these two layers This is essential as otherwise continuous cracks may be formed along these joints due to the shrinkage of the mud mortar This specification is followed even today while constructing any house or building with the help of bricks It is due to the same reason that is masonry is weakest at these junctions and could be strengthened somewhat if the joints are not continuous but are broken

In modern civil engineering construction, they adopt two types of arrangements of bricks- (i) English method (ii) Flemish method [15] It is very interesting to see the same method of arrangement of bricks in the construction of citis These two methods are as shown in the figure - 45a Bricks of modern days have several similarities with the bricks of Brāhmanas

Bricks in Engineering materials :

Engineering is an art of science where technology is applied to various disciplines of scientific research In engineering materials or building materials one part is called solid materials These solid materials are stones, bricks, iron, timber etc In the manufacture of bricks the following four operations are done

(1) Preparation of clay, (2) Moulding, (3) Drying, (4) Burning

This process is same as that described by the Brāhmana texts In modern engineering method the burning of bricks is done either in clamps or in kilns A kiln

15 Engineering materials, by S C Rangwala, P 75

Indological Truths

is a large oven which is used to burn bricks The Bull's trench kiln is one of the variety of the kiln which is as shown in the figure

Qualities of bricks according to Modern engineers:[16]

i. Bricks should be table-moulded, well burnt copper-coloured free from cracks and with sharp and square edges

ii Bricks should be uniform in shape and should be of standard size

iii Brick should give homogeneous and compact structure free from voids

iv Bricks should be suffciently hard No impression should be left on the brick's surface, when it is scratched with finger nail

v Bricks should not break when dropped flat on hard ground from the height of about one metre

If we compare the specifications what I mentioned before according to Satapatha Brāhmana, I may conclude that the technology of using burning bricks was developed at the time of Śatapatha Brāhmana itself and their construction like modern civil engineer's method may have started at the time of Śulbasūtra period

The next specification given is that bricks made of material other than soil should not be used according to BŚS[17] It is further clarified that bricks of any material which are not shaped like bricks should not be used Materials of different strength, when used for masonry, form a weak spot and cracks may be developed at these locations because of this reason

Specifications for brick construction peculiar to citi are given below

1 The number of bricks for construction of a citi, if it is being constructed for the first time, is one thousand[18] There are five layers of bricks in one citi

16 Engineering materials, P 85-86

17 साहस्र चिन्वीत प्रथम चिन्वान । B Ś S 2 26

18 द्विशत चिकीर्षेत् पञ्च चोडाभिः । B Ś S 2 28

Indological Truths

Each layer is constructed of 200 bricks [19] The height of the citi which is being constructed for the first time is equal to one jānu (i e 32 angulas) All the layers are of equal heights (except in case of śmaśāna citi) The height of bricks called Pañcacoda and Nākasadā is one half of the other bricks [20] while counting the number of bricks two of these bricks are counted as one [21]

ii The bricks are to be marked, probably by ash from ukhā, so as to denote their locations in a citi The bricks on which L-shaped mark is made such that the short side is towards the south, are located in the southern part of the citi The bricks that are to be placed on the left side of the citi are marked with L-shaped mark of which the short side is turned towards the north (left of the brick layer) The bricks marked with a stright line are located on the eastern and western part of the citi The bricks to be placed in the middle of the citi are marked with three stright line [22]

iii The citi is constructed with its front side towards the east [23]

iv The instruction that bricks are to be placed towards the east, towards the west etc means that they are to be placed towards these directions with reference to the citi The instructions for placing bricks of rectangular size are given stating that they are to be oriented towards the east or towards the south etc This means the longer side of the brick is to be oriented towards the east towards the south etc All these instructions are given with the

19 ऊर्ध्वप्रमाणमिष्टकाना जानोः पञ्च कारयेत् । – B Ś S 2 58

20 अर्धेन नाकसदा पञ्चचोडाना च । id 2 28

21 था दक्षिणावृतो लेखास्ता दक्षिणत उपदध्यात् । – B Ś S 2 30-33

22 B Ś S 2 30-33

23 B Ś S 2 38

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assumption that the brick-layer is facing the citi with its face towards the east [24]

v The height of the citi when constructed for the first time is equal to one jānu (32 angulas) and the total number of bricks should be one thousand When the citi is to be constructed for the second time then the height of the citi should be upto one nābhi (64 angulas) and the number of bricks are to be two thousand When the citi is to be constructed for the third time then the height is to be upto the mouth (96 angulas) of the sacrificer and the number of bricks[25] should be three thousand

According to Baudhāyana[26] and Āpastamba[27], the area of the citi being constructed for the first time is $7^1/_2$ sq purusa Its height is one jānu and number of bricks is one thousand At the second time of the construction of same citi its area is increased by one purusa i e $8^1/_2$ sq purusas The height of the citi is increased by one twenty-fourth of one fifth of jānu (9 tilas) With each addition, in the number of times the citi is constructed Its area is increased by one sq purusa and its height by nine tilas The largest area of the citi shall not be more than $101^1/_2$ sq purusas

With the increase in area of the citi, the size of the bricks is to be increased but their number remains the same, i e one thousand (Method of increasing the area of the citi is explained at the end of this chapter)

It is to be noted that MŚS does not follow the rule of one thousand Further, the number of bricks in each layer also may not be the same The citis described in MŚS where number of bricks used to be more than thousand [28]

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24 BŚS 2 48-51

25 ĀŚS 10 18-20

26 BŚS 2 1-4 2-13

27 ĀpŚS 8-9-13

28 MŚS 3 2 - The number of bricks in the first and second layers of caturasra śyena citi (type II) are 306 and 249 respectively In the same chapter para iii, the number of bricks in the first layer and the second layer of caturasra śyena citi (type iii) are 476 & 429 respectively

Indological Truths

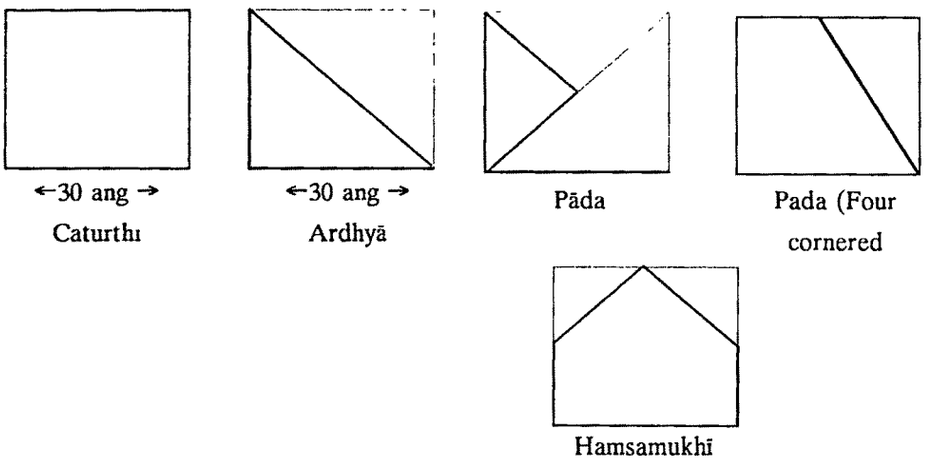
Formation of different bricks :

To construct a citi in different layers, the bricks of different shapes are required These include square, triangle, pentagon, rectangle etc These different shapes of brick is not constructed separately Only one type of brick usually a square brick is prepared The method of preparation is already explained This square brick is cut into different shapes whichever is required

When a square brick (caturthi or pañcami) is cut by one of its two diagonals each of the two equal parts gives rise to a brick as shown in the figure [29] It is having the face of an isosceles triangle When it is cut by its two diagonals, each of the four equal pieces gives rise to a brick having the shape also of an isosceles triangle and when cut by its two bisectors of the sides, each of its four equal pieces give rise to a brick having the face of smaller square When divided simultaneously by two diagonals and two bisectors of the sides, each of the eight equal pieces give rise to another brick with the shape of an isosceles right angled triangle [30]

When any of the smaller square is divided into two equal halves by a bisector on one of the sides, each give rise to a brick which is one-eighth of the original caturthi or pañcami When longer side of the rectangular aṣṭami is joined with one of the sides of the isosceles right angled triangle, it gives rise to a brick having the shape of a trapezium When two such trapeziums are joined together along its longer

29 Sizes of the bricks



30 B S S 4-2-7

Indological Truths

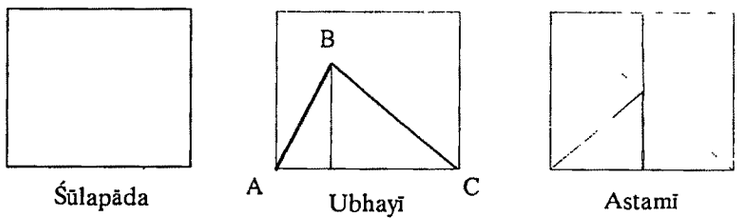
sides, it gives rise to a hamsamukhi brick with its face representing a pentagon, when an adhyardhā representing a pentagon When an adhyardha brick (one and half times) of a square brick i e a rectangular brick) is cut along its two diagonals, it gives rise to four triangular pieces two equal larger known as dīrghapādya bricks and two equal smaller known as Śūlapādya bricks When a dīrghapādya is having a triangular face is cut into two equal halves by cutting along the perpendicular line from the vertex to the base of the triangular face, it gives brick with the face of a right-angled triangle Similarly when a Śūlapādya brick having a triangular face is divided into two equal halves by cutting it along the perpendicular line from the vertex to the base of its triangular face, each gives a brick having a face of the shape of a right-angled triangle [31] If a brick having the face of shape of a right-angled triangle derived from dīrghapādyā or Śūlapādyā be joined to a similar one derived from the pañcami among the sides of equal length, it gives rise to a brick whose face represented by a scalene triangle as in the figure - 31

From the consideration of above description for the preparation of various bricks for the construction of altars, it can be concluded that the ancient Indians had the empirical knowledge of different forms of geometrical figures viz square, rectangle, isosceles triangle, isosceles right angled triangle, scalene triangle trapezium, pentagon etc

Symmetrical construction method :

These different types of bricks arranged in a systematic manner in different layers Bodhāyana further insisted on the symmetrical construction of the citi He mentioned that the citi is to be constructed by arranging bricks in symmetrical manner For this purpose Bodhāyana has given an example of the symmetrical arrangement

31 B Ś S 4 56-63



Śūlapāda Ubhayī Astamī

Indological Truths

of bones in the body of an animal The other śulbasūtrakāras followed this rule except in cases where it is unavoidable [32]

But one thing is very clear, at the time the śulbasūtra period, the technology of preparation of bricks, and arrangement of bricks was developed in a very scientific way Now the builders use hte rope for the planning and marking of any house or building, and even for finding the vertical column of arrangement of bricks in different layers This technology, or geometric idea, must be developed at the time of śulbasūtra period

Construction of various citis (fire-altars) :

Nitya citis The three 'nitya agnis' (or perpetual fire-altar) were the gārhapatya, the āhavanīya and daksināgni and meant for daily sacrifices I have already shown that origin of three fundamental altars are as old as Rgveda It is said taht Agni kindles the Agni[33] which is symbolically enacted in kindling the āhavanīya fire from gārhapatya fire According to Ṛgveda[34] Agni is all pervading and ever present as baḍabānala (बडबानल) in the ocean, as āditya (the sun) in the heavenly firmament and as vidyutagni (the thunder-bolt) in the midregion and he is hidden in the earth, he is the inner controller of all things and indeed he becomes the visible god when the sacred fire is set upon the gārhapatya fire (viz the household fire) is regarded as the foremost (purovarti) representing human beings on earth [35] The āhavanīya fire is symbolic of the sun in the celestial region where gods abide [36] The daksināgni is symbolic dwell in the mid-region,[37] this represents the wind god (वायुः) for when

32 पशुधर्मो ह वा अग्निर्यथा ह वै पशोर्दक्षिणैषामस्थ्ना यद् दक्षिण पार्श्वं तदुत्तरेषामुत्तर यदुत्तरेवा दक्षिण तद् दक्षिणेषामुत्तर यदवाक् चोर्ध्व च तत्समानमेव मिष्टकाना रूपाण्युपदध्यात् ॥ B Ś S 2 29

33 अग्निनाग्निः समिध्यते । Rg 1 12 6

34 त्रीणि जानापरिभूषयति अस्य । Rg (1 95 3)

35 समिद्धो अग्निर्निहितः पृथिव्याम् । प्रत्यङ्विश्वानि भुवनान्यस्थात् होता पावकः प्रदिवः सुमेधा देवो देवान् यजत्वाग्निरर्हन् । Rg 2 3 1

36 एतद् वै देवानाम् आयतन यद् आहवनीयम् । Tai Sam 1 6,7,1

37 अन्वाहार्य पञ्चानः पितृणाम् । Tai Sam 1 6 7 2

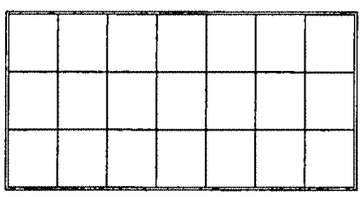
Indological Truths

man dies he departs from here to the realm of vāyu [38] Since gārhapatya fire represents earth, fire-altar constructed in the form of circular shape The daksināgni is symbolic of Ākāśa (or vāyu) it is constructed in the half moon (or semi-circular) shape, while the āhavanīya which is the symbolic of the heavens or celestial region is of the form of square in shape [39] If a person who maintains these three fires is called Vaitānika

Construction of Gārhapatya fire altar :

Now, we find it from the śulba, that the altar of the gārhapatya must be of the form of a square, according to one school and a circle according to another school [40] But the area is always one sq vyāyāma It is constructed with 21 bricks in each other According to all the saṃhitas[41] and brāhmanas[42] as in the śulba, the gārhapatya citi must be constructed with the same number of bricks, namely, 21 arranged in an identical manner For the placing bricks in a square gārhapatya, the following two methods are adopted as mentioned in BŚS

First Method One side of the square is divided into 3 parts by drawing 3 parallel lines and the other into 7 parts by drawing 7 parallel lines These lines divide the square area into 21 rectangles and bricks are accordingly made This is the first layer For the second layer, the bricks are arranged differently in the square



38 यदा वै पुरुषोस्मात् लोकात् प्रणति स वाय आगच्छति । Ś Br 14 8 2 1

39 मण्डल गार्हपत्यस्य अर्धमण्डल दक्षिणाग्नेः ।
चतुरस्रमाहवनीय नैतिह्यासिकाः सर्वाणि ।
चाऽऽयतनानि क्षेत्रहस्तुल्यानीत्याहुरिति च । अग्निहोत्र चाधिका पु ।

40 B Ś S 7 4

41 M Ś S III 2 3, K S XX 1, Kaps xxxii 3

42 Ś Br VII II, 18 33 4

Indological Truths

Second Method Three kinds of square bricks are made with 6th, 4th and 3rd part of vyāyāma The first layer is prepared with 9 bricks of the first kind and 12 bricks of the second [see fig (a)], and the second layer with 6 bricks of the third kind and 16 bricks of the first as in fig (b)

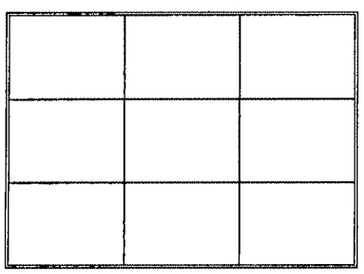


Fig (a)

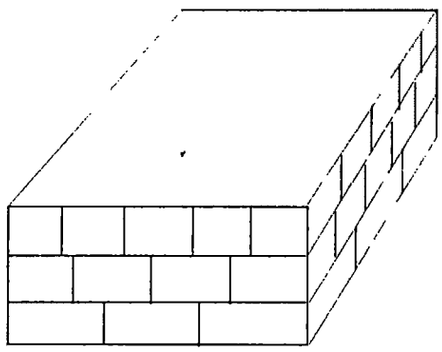
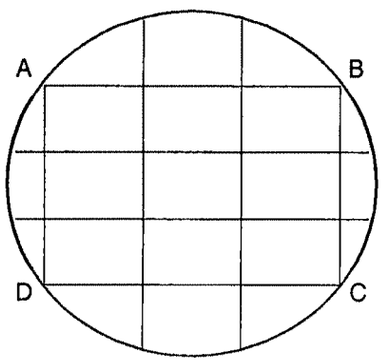
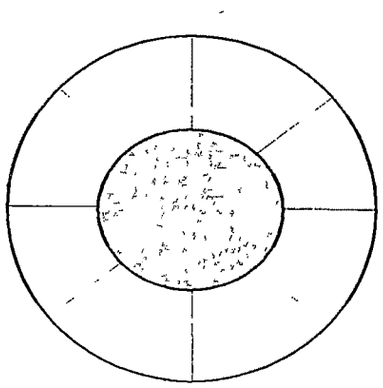


Fig (b)

Circular Gārhapatya citi :

For the construction of the circular gārhapatya citi, within the circle a square of the maximum size possible is drawn and divided into 9 parts (squares) The segments of the circle (between the circumference and the square) are divided into 3 parts each The second layer is placed in such a way that the corner (of the square within the circle) lie at the centres of the segments (of the first layer)





In the above figure the square ABCD is then divided into 9 equal parts by 3 parallel lines from one side and 3 from the other side and each segment is divided

Indological Truths

The Layout of the Soma Sacrifice with the Citi (K)

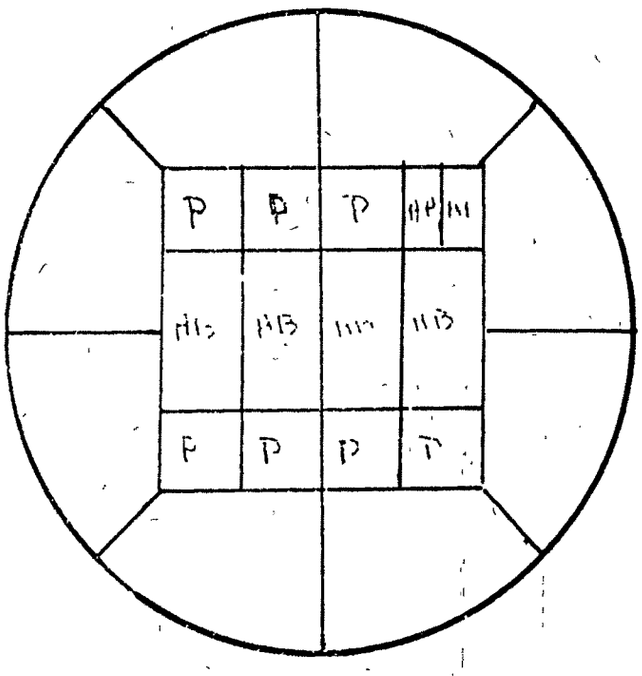
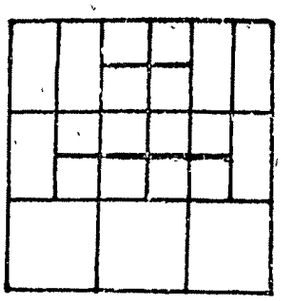
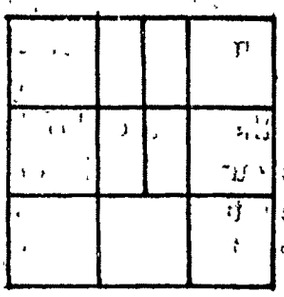


Fig. 24.1 the Gārhapatya citi

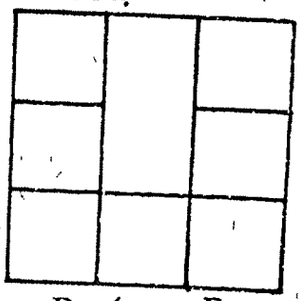
P = Pāda Bricks
A.P. = Ardhapādyā Bricks
A.B. = Aidhabṛhati Bricks



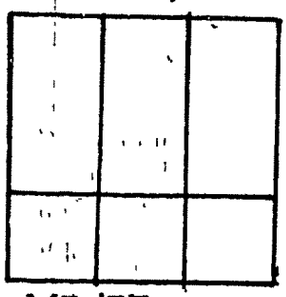
Hotṛ



Brāhmaṇacchamsi



Praśastṛ Potr
Nestṛ Acchavāka



Mārjālīya

Dhiṣṇya

Indological Truths

into 3 equal parts Hence the whole circle is divided into 21 parts and bricks are accordingly made for the first layers.

In the second layer the square is so adjusted that the corners A, B, C and D are placed in the middle points E, F, G and H of the segments

Āpastamba considered the construction of both square and circular gārhapatya fire and it has the measure of 1 vyāyāma [43]

In MŚS, the construction of gārhapatya citi is constructed with the measurements of bricks Six kinds of bricks are used for the construction of gārhapatya fire-altar The measurements are- 12 ang x 24 ang , 24 ang.x 24 ang , 12 ang x 12 ang , 12 ang x 6 ang , 12 ang x 18 ang , and 30 ang x 30 ang The height of these bricks is 6 ang [44] Mānava gives no idea as to how to arrange the bricks in the first and second layers

Gārhapatya fire which are described in the śulba can be traced back to the earlier scriptures like Taittirīya saṃhita and Śatapatha Brāhmana etc

In the Tai Saṃhita it is so ordained that the gārhapatya citi is to be constructed with 21 bricks arranged in an identical manner [45] Similar passages are also found in the Maitrāyanī Samhitā, Kāthaka Samhitā and Kapiṣṭhala Samhitā In Tai Sam it is also said that, "He who constructs (the gārhapatya citi for the first time should construct in five layers He who constructs for the second time should construct in three layers "[46] Thus these informations with full details is found in Śulbasūtras with systematic manner

Construction of Dhiṣṇya, Agnīdhriya, Mārgālīya and Chanda Fire-altas :

Śulbasūtras explains the construction of other fire altars According to Baudhāyana, Āpastamba & Mānava Śulbasūtras, Dhisnya has one layer only It may be a square or a circle Generally it is covered with sand on which the fire is placed [47]

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43 ĀŚS 7 3 to 7 5

44 M Ś S 6-1 to 6-3

45 प्रतिष्ठ्या वा एकविंशः गार्हपत्या एकविंश स्वाविव प्रतिष्ठ्या गार्हपत्यमेनु प्रतितिष्ठति । Tai Saṃ 5 2 3 5

46 पञ्चचितिक चिन्वीत प्रथम चिन्वानः त्रैचितिकाम अन्वीत द्वितीय चिन्वान (Tai Sam 5 2 3 6

Indological Truths

The 'āgnīdhrya' may also be a square or circle When it is in the form of a square, it is divided into 9 small squares and central brick is replaced by a piece of stone The same method is also given by Mānava (MŚS 6 10) When it is circular, a round stone of 8 angulas diameter is placed in the centre of the circle and the remaining area divided into eight equal parts as shown in the figure - 46

Fire-altars (or citis) of Kāmya Agnis:

Since soma sacrifice is performed for the fulfilment of a particular wish of the sacrifices, they are, therefore called Kāmya sacrifices [48] Information about the name of the citi and the wish of the sacrificer that can be fulfilled by performing a soma sacrificer with that citi as uttaravedi is given in the table below as found in the Taittirīya Samhitā [49]

Name of the Citi	The desire of the sacrificer that is satisfied
Śyenaciti (caturaśra or in form of bird)	To reside in heaven after death
Chandaściti (in the form of a bird)	Desiring cattle
Kankaciti (-- do --)	To reside in heaven
Alajaciti (-- do --)	Desiring support from the heaven
Prauga (in the form of an isosceles triangle)	Annihilation of rivals (for nullifying an enemy attack)
Ubhayatāprauga (in the form of a rhombus)	For warding off an enemy attack
Rathacakraciti (in the form of a chariot wheel, in circular)	For the victory over the enemy
Dronaciti (in the form of trough)	For gaining food
Paricāyyaciti (in the form of a circle)	Desiring a region
Śmaśānaciti (in the form of a pyre)	Attaining the place where the fore-fathers have gone (pitrloka)

47 BŚS 7-9-10 ĀŚS 7 7-8 MŚS 6 10

48 अन्ते काम्यस्य कर्मणः । Rg 10 50

49 छन्दश्चित चिन्वीत पशुकामः पशवो वै छन्दासि पशुमानेव भवति श्येनचित चिन्वीत स्वर्गकामाय श्येनोऽवै वयसा

Indological Truths

The placements of bricks, size of the bricks, dimensions, specifications of the above are listed in a separate table - 9 in the Appendix I

Śulbasūtras give rules for all forms of citis and its constructional details that are rarely found Of these, the construction of the Śyena citi was the most complicated and it was of many kinds They are as follows

Construction of a Rectilinear Śyenaciti - First type

Baudhāyana, Āpastamba and other Śulbasūtrakāras have considered the construction of two categories of Śyenacit (falcon-shaped fire altar) (a) the first category in which the body, the wings and the tail are rectilinear (squares and rectangles) and (b) the second category in which the wings are curved, the tail spread out and the head has its corners cut off In the latter case the shape of the altar more closely resembles the falcon

References of Śyena citi is found in the Taittirīya Samhita,[50] Maitrāyanīya Saṃhitā[51] and Śatapatha Brāhmana [52] A certain bird represented as the standard form of a kāmya sacrifice [53] A clear reference to this form is found in the Rgveda where Agni is frequently called a bird [54] The area on which these fire-altars were drawn covered $7^1/_2$ sq purusa which is same as that of Śulbas The shape and size of the falcon-shaped fire-altar wer also given in almost all the earlier works,[55] they are exactly the same as those that are found in Śulba For example the sūtra 8 4 (111 7) of Baudhāyana Śulbasūtra was same as that of Taittirīya Samhitā-

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प्रतिष्ठाः श्येन एव भूषा स्वर्गं पतति कङ्कचित चिन्वीत यः कामयेत शीर्यशन्वानामुष्मिल्लोके स्यामिति शीर्षान्वानेवामुष्मिल्लोके भवत्यवलजचित चिन्वीत चतुःश्शमीत प्रतिष्ठा कामश्चतस्रो दिशो दीक्ष्वेव प्रतितिष्ठति । प्रउगचित चिन्वीत भ्रातृव्यान् प्रैव भ्रातृव्यान् तुदत उभयतः प्रउगण चिन्वीत यः कामयेत प्रजातान् भ्रातृव्यात् श्यनिचक्रचित चिन्वीत ग्रामकामो श्मशानचित चिन्वीत स. कामयेत पितृलोक. । Tai Sam 5 4 11 1-3

50 Tai Sam V 4 11 1

51 M S S vi 4 4

52 S Br X2 2 4

53 ĀŚS 8 1

54 Rg I 164 52, 10 14 5 Compare also with 1 58 5, 1 41 7, 2 24

55 Tai Saṃ 5 2 5 1

Indological Truths

"Five (bricks) are placed in the southern corner and five in the northern (let there be) the strength of the goat with these (words) he places (the bricks) in the southern corner (let there be) the strength of the tiger, with these he places in the southern wing (let there be) the strength of the lion- with these he places in the northern wing, and (let there be) the strength of the man with these he places in the middle"[56]

The construction of the fire-altar after the shadow cast on the ground by flying bird is also given in the same Brāhmana [57]

Regarding the height of Śyena citi, Taittirīya samhita observes as follows

"He should pile (the fire) of a thousand (bricks) when first piling (it), this world is commensurate with a thousand verily he conquers this world He should pile (it) of two thousand, when piling a second time, atmosphere is commensurate with two thousand, verily he conquers this world He should pile (it) of two thousand, when piling a second time, the atmosphere is commensurate with two thousand, verily he conquers the yonder world Knee-deep should be pile (it) when piling for the first time, verily with gāyatrī he mounts this world, naval-deep should he pile (it) when piling for the second time, verily with the triṣṭubh he mounts the atmosphere, neck-deep should he pile (it) when piling for the third time, verily when the jagati, he mounts the yonder world "[58]

But the full details of the methods of measurement of the falcon shaped fire-altar found only in Śulbasūtras

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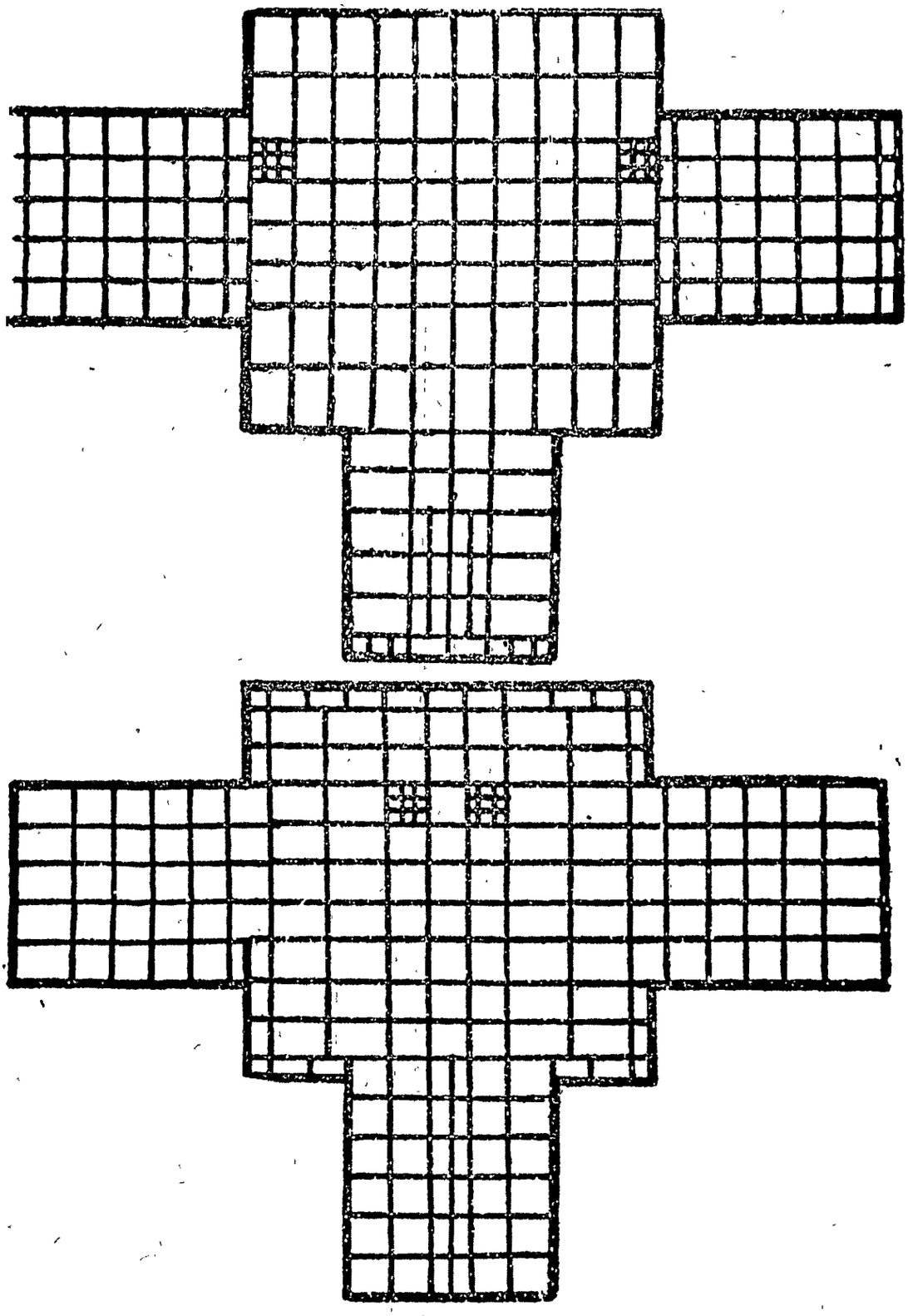
56 पञ्च दक्षिणायाः श्राव्यमृषदधाति पञ्चोत्तरस्या वास्तोव्य इति दक्षिणो स उपदधाति वृष्णिर्वय इति उत्तरे व्याघ्रो वय इति दक्षिणे पक्ष उपदधाति सिंहो वय इत्युत्तरे पुरुषो वय इति मध्या इति च ॥ Tai Saṃ 5 3 1 5 Compare with 8 4 Sūtra of B Ś S in the appendix

57 अथापर वयसा वा एष प्रतिमया चीयते यदाग्निरिति । Tai Saṃ

58 सहस्र चिन्वीत प्रथम चिन्वानः सहस्रसम्मितो वा अय लोक इमामेव लोकामाभि जायति द्विसहस्र चिन्वीत द्वितीय चिन्वानो द्विसहस्र वा अन्तरिक्षमन्तरिक्षमेवाभि जायति त्रिसहस्र चिन्वीत तृतीय चिन्वान त्रिसहस्रो वा असौ लोकोमुमेव लोकामभिजयति जानूदग्ध चिन्वीत प्रथमं चिन्वानो गायत्रीयैवेमं लोकमभ्रोहति नभिदघ्न चिन्वीत द्वितीय चिन्वानत्रिष्टुवान्तरिक्षमभ्यरोहति ग्रीवाघ्न चिन्वीत तृतीय चिन्वान जगतैवाममु लोकामभ्यरोहति ॥ Tai Sam 5 6 8 2-3

Indological Truths

Layout and Construction of the Citis



Caturasra Śyena Cīti (Type I)

Indological Truths

Layout of the Citi:

BŚS [59] explains the layout of the citi The body of the Śyena is square in shape and its area is four sq purusas The length of its side is therefore two purusas The southern wing is rectangular in shape, its length being one purusa and one aratni (144 angulas) Its width is equal to one purusa (120 angulas) The northern wing is identical with the southern wing The tail is also rectangular in shape its length being one purusa and one pradeśa and its width is one purusa The total area is $7^1/_2$ sq purusa

Area of the body = 4 sq purusas

Area of the two wings = $2^2/_5$ sq purusas

Area of the tail = $1^1/_{10}$ sq purusas

Total area = $7^1/_2$ sq purusa

Since, the body of the Śyena is square in shape, a square of area four sq purusas is constructed Śulbasūtras given different methods to construct a square with the help of cord and bamboo rod

For the construction of Rectilinear Śyena citi square bricks (of sides) the fourth, the fifth, the sixth and the tenth part (of a purusa that is 30, 24, 20 and 12 angulas respectively) are made as said in B Ś S [60] Therefore the following four types of square bricks are used for the construction

A_1 → one-fourth brick (caturthi) - 30x30 sq angulas

A_2 → one-fifth brick (pañcami) - 24x24 sq angulas

A_3 → one-sixth brick (sasthi) - 20x20 sq angulas

A_4 → one-tenth brick (daśami) - 12x12 sq angulas

(The diagram of these bricks are as shown in the figure)

Measurement of the fire-altar:

In this fire-altar, the body (ātman) is a square and the two wings and the tail are rectangles To set up these rectilinear figures of required areas on the ground,

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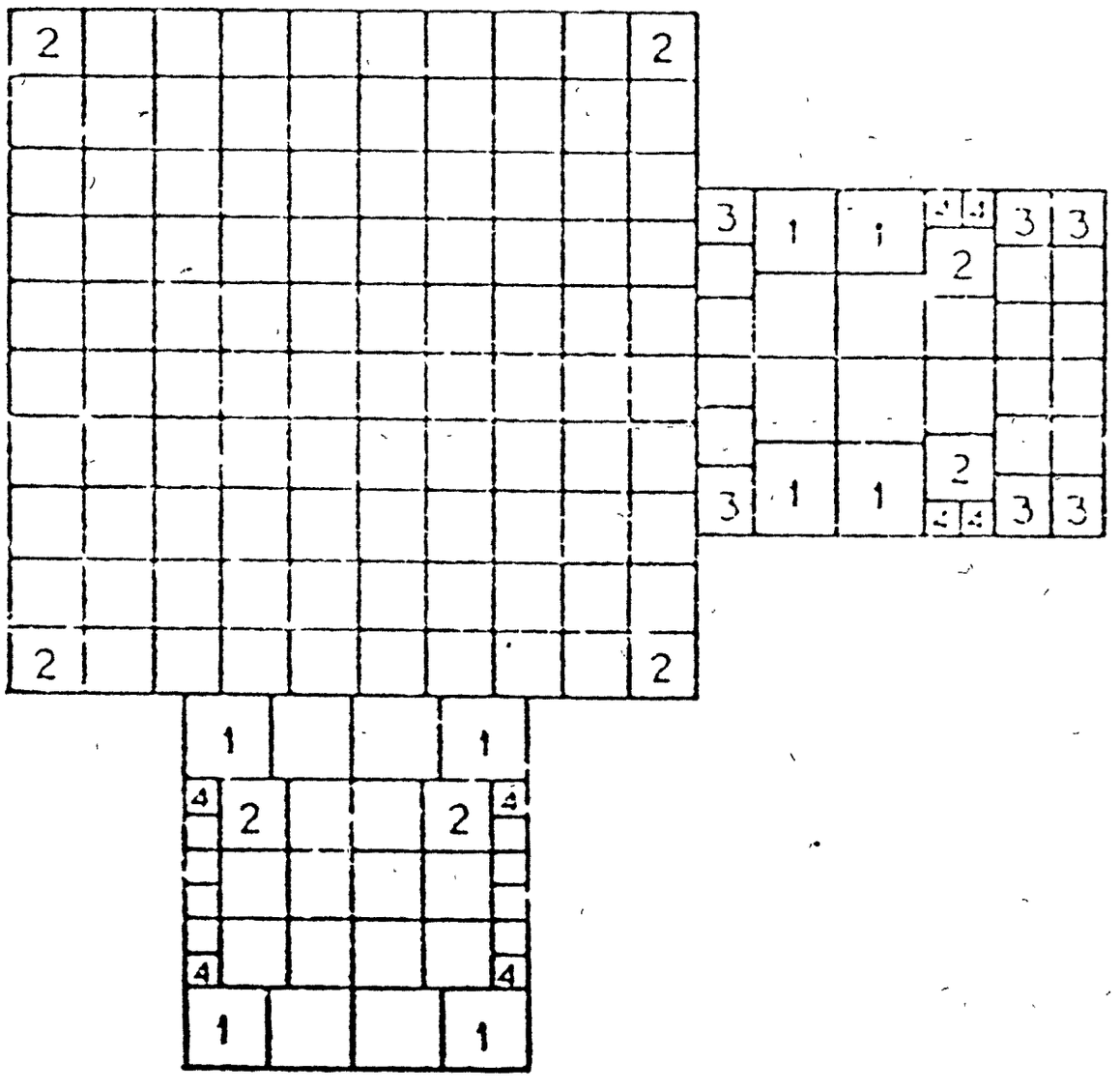
59 B Ś S 3-16-23

60 B Ś S 8-6-7

Indological Truths



. Arrangement of bricks in the first layer of a *caturaśra śyenacit* (northern wing not shown). Fig 48

Indological Truths

one can use either a cord or a bamboo rod and follow the rules of construction of such figures For measurement with a bamboo rod with a hole at either end and at a middle Āpastamba has given greater details which are considered later

Baudhāyana states-[61] "the body is a square of 4 sq purusas, that is, of side 2 purusas or 240 angulas At the middle of its southern and northern side, a rectangle each, measuring 144 angulas x 120 angulas, with the longer side drawn south-north, is set up, this will represent the south and the north wing A rectangle of 132 ang x 120 angulas with the longer side towards east-west attached to the middle of the western side of the body is the tail The area of the altar is-

$^{1}/_{1202}$ [2402 + 2x144x120 + 132x120] = 71/2 sq purusa required in the text

Placement of bricks in the first layer:

According to Baudhāyana the first layer of rectilinear Śyenaciti is as follows "The bricks are placed at a distance of one-third purusa (40 angulas) to the north from the end of the (southern) wing, 4 bricks of side equal to one-fifth (of a purusa) and 2 quarter bricks (one-fourth of the area of a pañcami brick, i e 12 sq angula) (are placed) Thereafter 8 bricks of side equal to one fourth (of a purusa) are placed The remaining space of the southern wing is covered with bricks of side equal to one-sixth of a purusa Thereby the northern wing is explained Bricks of side equal to one-fourth (of a purusa) are to be placed on the eastern and the western side of a tail, and quarter bricks on its southern and northern side The remaining space of the (southern) wing is covered with bricks of side equal to one-sixth (of a purusa) Thereby the northern wing is explained [62] (See the diagram 48)

Bricks of side equal to one-fourth (of a purusa) are to be placed on the eastern and the western side of the tail, and quarter bricks on its southern and northern side The remaining space of the fire-alter is to be covered with bricks of side equal to one-fifth (of a purusa) This is one layer of 200 bricks

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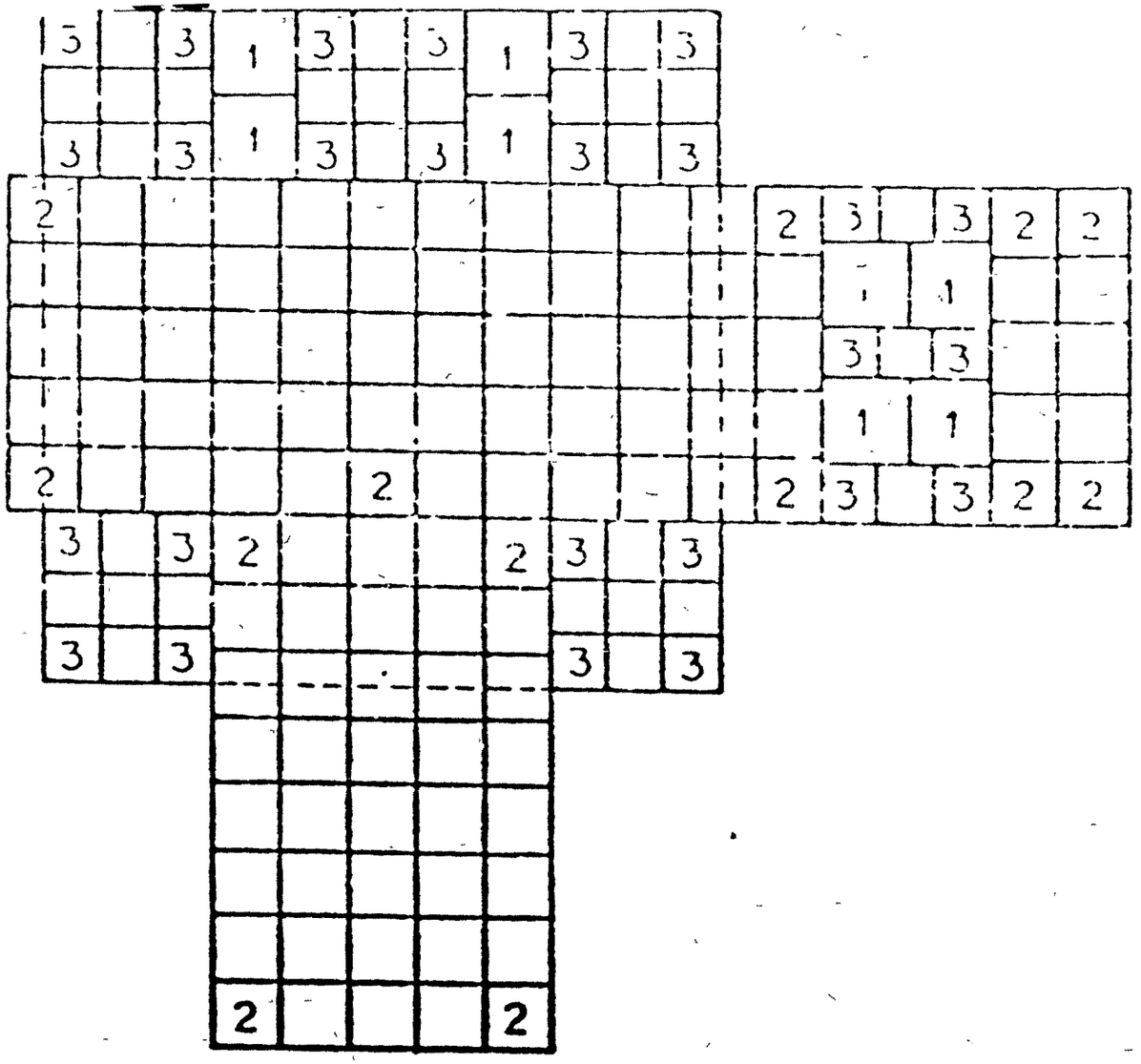
61 BŚS 8 8-10

62 BŚS 3 24-31

Indological Truths



Arrangement of bricks in the second layer of a *caturaśra śyenacit* (north wing not shown). Fig 48

Indological Truths

The arrangement of bricks in the first layer

Parts of the Citi	Brick Type				Total
	1	2	3	4	
Body		100			100
Wings	16	8	36	8	68
Tail	8	12		12	32
Total	24	120	36	20	**200**

Arrangement of bricks in the second layer:[63]

In the second layer, place three sasthi bricks at the distance of half vyāyāma (48 ang) towards the north from the southern end of the southern wing, by turns and two caturthī bricks In the same way the bricks are to be placed in the northern wing

In the south-west corner of the body nine sasthi bricks are placed, arranged in a square The same is to be done in the north-west corner of the body Place nine sasthis and two caturthis by turn, beginning from the south-east corner of the body until one has reached the north-east corner The sasṭhi and caturthi bricks are similarly to be placed along the western side of the body The remaining areas of the body, tail and the wings are to be covered with bricks the sides which are equal to the fifth of the purusas (pañcami bricks) This is again a layer of 200 bricks

The arrangement of the bricks in the first layer is to be repeated for the third and the fifth layer and the arrangement of the bricks in the second layer is to be repeated for the fourth layer

Caturasra Śyena Citi (Type II) (See the diagram 49)

The layout of the citi is identical to that of type I

Sizes of the bricks

Square bricks are to be made the sides of which are equal to the fifth part of

63 BŚS 3-33-39

Indological Truths

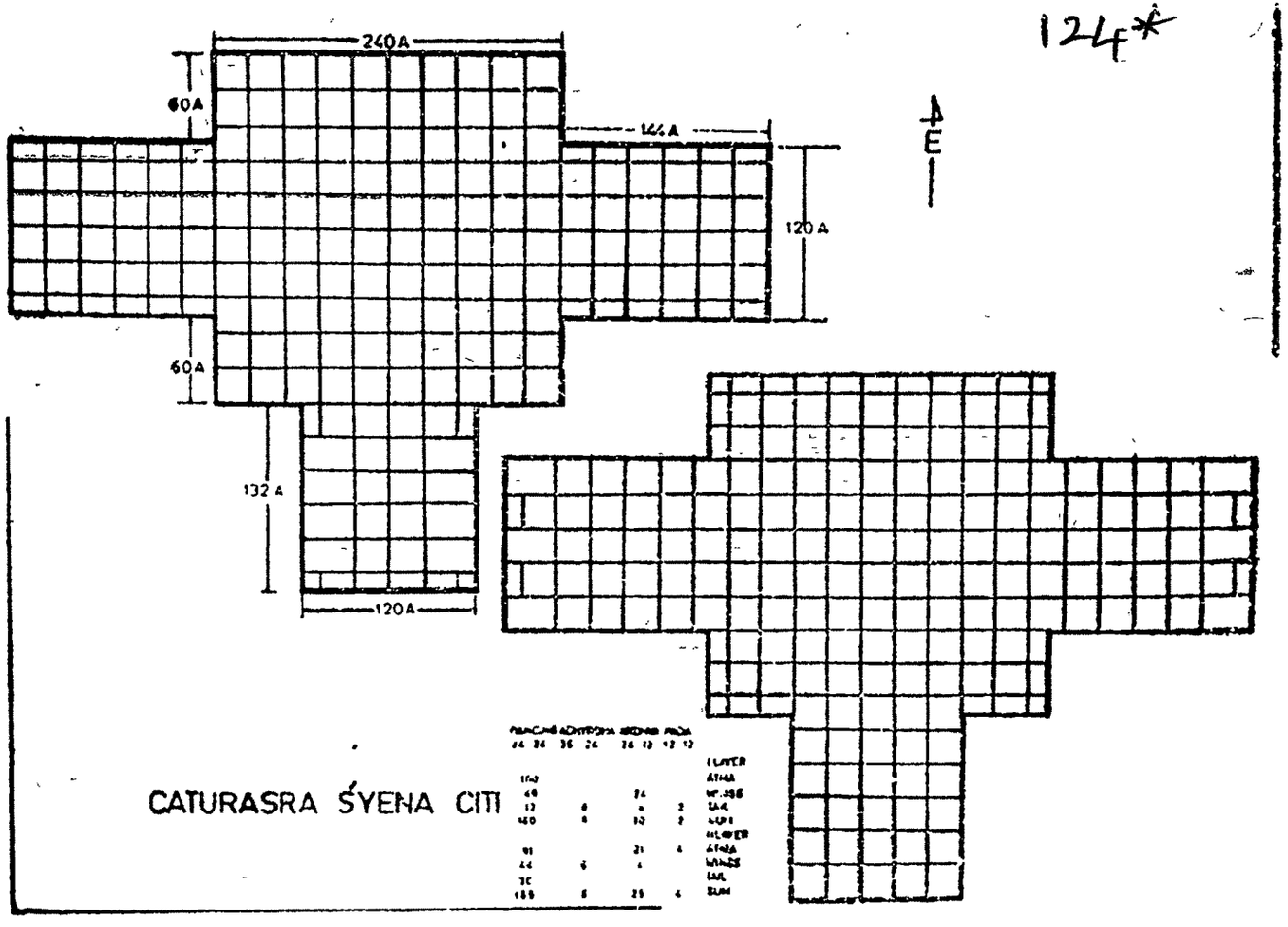


Fig. 3 Caturasra Śyena Citi (Type II)

Diagram 49

Indological Truths

a purusa (24x24 ang) Then make bricks which are longer on one side by a half, that is adhyardhā bricks of 36x24 ang Bricks of the size of pañcamis (12x24 ang) called ardhyā are to be prepared Bricks of sides of length equal to the half of these pañcamī bricks (12x12 ang) are also to be fabricated These are called Pādyā bricks

Arrangement of the Bricks in the First layer:[64]

Half bricks (12x23 ang), their length turned towards the north, are to be placed in the east and the west sides of the southern wing Six bricks are accomodated in the east side and six in the west side These bricks are similarly arranged in the northern wing The remaining area of each of the wing is to be covered by pañcami bricks

Bricks	Caturthī 30x30A	Pañcamī 24x24A	Ṣaṣṭhī 20x20A	Daśamī 12x12A
First layer				
Ātmā	–	100	–	–
Wings	16	8	36	8
Tail	8	12	–	12
Sum	24	120	36	20 =200

Bricks	Caturthii 30x30A	Pañcamī 24x24A	Ṣaṣṭhī 20x20A	Daśamī 12x12A
Second layer				
Ātmā	4	60	45	–
Wings	8	40	18	–
Tail	–	25	Ī	–
Sum	24	125	63	200

64 BŚS 3-46-63

Indological Truths

On the southern and on the northern sides of the tail four adhyardhās, their length turned towards the north, are placed such that the first of these bricks, beginning from the east, is situated at a distance of 24 angulas from the western side of the ātman, the last at a distance of 12 ang from the western end of the tail On the western side of the tail four half bricks, their length turned towards the north are placed On both the western corners of the tail two quarter bricks (12x12 ang), one at each corner are located At the two places where the tail is joined with western border of the ātman, in the two eastern corners of the tail, a half brick is to be placed turned towards the east The body is to be covered with pañcamī bricks This is the layer of 200 bricks

Arrangement of bricks in the second layer:[65]

In the second layer, one quarter brick (12x12 ang) is to be placed in each of the four corners of the ātman On the sides of each of the four quarter bricks, two half bricks (24x12 ang) are to be placed Thus 16 bricks are laid Five half bricks are to be placed on the eastern front of the ātman The remaining area of the ātman is to be covered by pañcami bricks Three adhyardhā bricks, turned towards the north, are to be placed at the end of each wing In each of the interstices between three adhyardhā bricks, one half brick is placed, turned towards the east The rest of the area of the wing is to be covered with pañcamī bricks (24x24 ang) The bricks of this layer to be 200 bricks The arrangement of bricks in the third, and the fifth layer shall be as described in the first layer The arrangement of fourth layer is similar to second layer

Construction of a square in different methods:

As it is already given, the construction of square is important in the Caturasra Śyena citi To construct a square, śulbasūtras described several methods which are purely geometrical methods and this may be considered as a contribution of śulbasūtras to the geometry of mathematics

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65 B Ś S 5 3 55-60

Indological Truths

First method

Having desired to construct a square, one has to take a cord of length equal to the side of the given square, make ties at both ends and mark it at its middle The (east-west) line (equal to the cord) is drawn and a pole is fixed in it (pole) and a circle is drawn with the mark Two poles are fixed at the both ends of the diameter (east-west line) With one tie fastened to the eastern (pole), a circle is drawn with the other A similar (circle) about the western pole The second diameter is obtained from the points of inter-section of these two (circles), two poles are fixed at two ends of the diameter with two ties fastened to the eastern (pole) a cricle is drawn with the mark The same (is to be done) with the southern, the western and the northern (pole) The end points of inter-section of these (four circles) produce the (required) square [66] This method of construction of a square may be shown in figure (1)

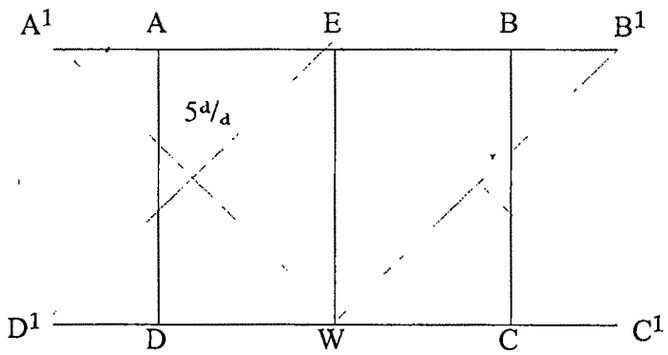
Let XY be the given cord and 'U' a mark at its middle, EW, the prāci of the figure = XY, O the middle point of EW obtained corresponding to U of XY, where a pole is fixed A circle with O as centre and OE as radius is drawn Then EW is a diameter of the cricle along east-west line Two other circles with E and W as centres and EW as radius are separately drawn The points of intersection of these two circles are denoted by N and S of the circle whose centre is O Again fastening the two ties once at E,W,N and S and drawing areas, the points A,B,C,D are fixed Then ABCD gives the required square

Method 2 "Ties are made at both ends of a cord twice the measure and a mark is given at the middle This (halving of the cord) is for the east-west line (that is, the side of the required squares) In the other half of the cord at a point shorter by one-fourth, a mark is given, this is the nyañcana (mark) (Then) a mark is given at the middle (of the same half cord) for purposes of (fixing) the corners (of the square) With the two ties fastened to the two ends of the east-west line, the cord is to be

66 This method occurs only in the Baudhaayana Śulba B Ś S 1-4 (1-22-28)

Indological Truths

stretched towards the south by the nyañcana (mark), the middle mark of the half cord) determines the western and eastern corners of the square "[67]



EW=athen, AE=EB=DW=WC=$^{a}/_{2}$ $A^{1}E=EB=D^{1}W=WC^{1}=3^{a}/_{4}ED^{1}=EC^{1}=WA^{1}=WB^{1}=5^{a}/_{4}$

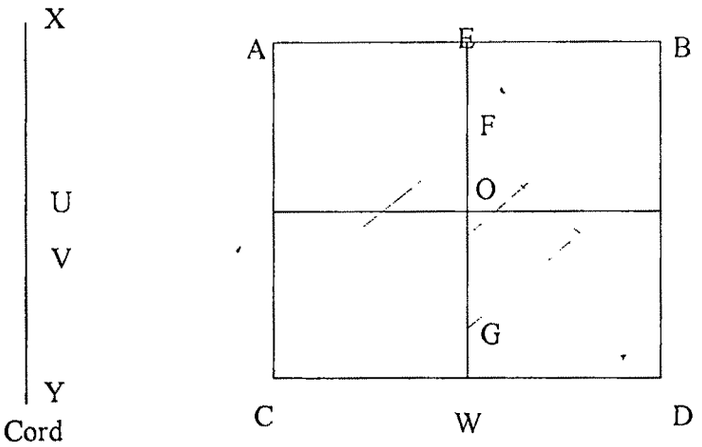
Method III Āpastamba[68] described another method for the construction of a square 'Poles are fixed at both ends and in the middle of the east-west line A cord measuring half of the east-west line is taken and increased by its viśesa (the difference between its length and the diagnol of the square produced by it)

After giving a mark at this point, the cord is further increased by half of the east-west line Ties are made at both ends of the cord Fixing the tie at the savišesa end at the middle pole, and the other tie at the eastern pole, the cord is stretched by the mark 80 as to obtain the south-eastern corner By removing the tie from the eastern pole and fixing it to the western pole, the south-western corner in likewise obtained by (stretching the cord with) the mark

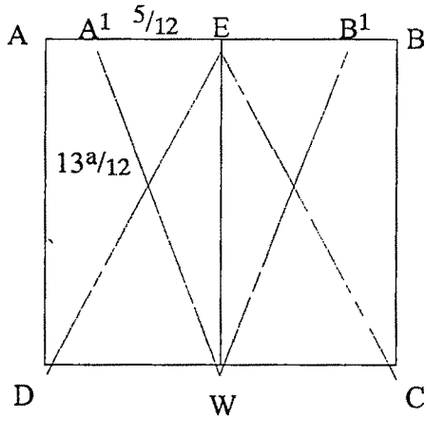
67 B Ś S (1-3, iii-29-38), Āp Ś S i-3, K Ś S i-12-3

68 ĀŚS 8 4-8

Indological Truths



Method IV "Add to a cord as long as the given side its half and make a mark at a distance (from the other end of the added portion) less by its sixth part Fasten the ends of the (increased) cord at the extremities at the east-west line and stretch it towards the south having taken by the mark and put a sign at the point reached by it Do similarly on the north and again on both sides after interchanging the ends of the cord This becomes the construction of a square [69]



EW=a the given side AE=EB=DW=WC=$^{a}/_{2}$

$A^{1}E=EB^{1}=D^{1}W=WC^{1}=5^{a}/_{12}$ $ED^{1}=EC^{1}=WA^{1}=WB^{12}=13^{a}/_{12}$

Method V In a bamboo-rod make two holes as much apart as the height of the

69 ĀŚS 8-4-7

Indological Truths

sacrificer with the uplifted arms and a third holes (c) mid-way between them Place the bamboo-rod on the east to west line and fix poles in the holes (beginning) from the western extremity of the sacrificial place Then freeing the two poles on the west describe a circle (by rotating the bamboo) south-eastwise by the hole at the (opposite) end. Then undoosing the eastern hole and fixing the hole in the west (in its original position), describe another circle south-westwise by the hole at the opposite end Now release the bamboo (completely) fix again an extreme hole at the middle pole (c) place it towards the south over the point of intersection of the two circles and fix a pole at the point reached by the outermost hole Then fix at this pole the middle hole of the bamboo and having laid it along the extreme outer edges of the two circles fix too poles at the two (outermost) holes [70] This is a square of (side equal to) one purusa This can be explained in mathematical way as follows

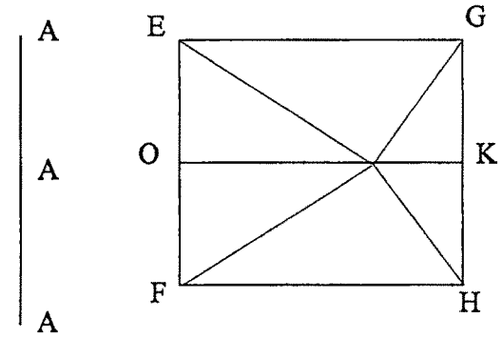


Fig (a)

Fig (b)

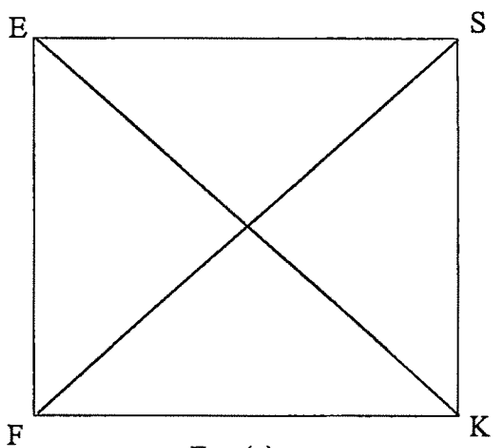


Fig (c)

A, B → holes at the end of a bamboo rod taken equal to the height of a sacrificer with uplifted arms,

C → another hole at the middle of ABl, as in the fig (a),

EF → the east-west line AB,

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70 ĀŚS 8-4-9

Indological Truths

FG, EH → arcs drawn by the end BA is fixed at O and then at F respectively,

O → the pole corresponding to the hole C of AB,

P → the point of intersection of the arcs FG & EH,

K → the point reached by the hole B when A is fixed at O and AB is laid over OP,

G, H → points fixed by A and B when C is fixed at K

Hence EFGH is the required construction of the square as in the fig (b)

The second method is explained as in fig (c)

FS → the bamboo rod which is equal to 2 a (dvikarani of the square) where 'a' equals one purusa

ES → the bamboo rod of length one purusa is stretched along the east side

S → the common point denoting aṃśa, which is one of the corner points of the figure which forms a square of one purusa Four such squares each of 1 sq purusa form the body (ātma) of the caturasrasyena citi

Caturasra śyena citi according to Āpastamba: (See the diagram 50)

Layout of the citi [71]

The body of the citi is a square of the sides two purusas long The wings are rectangles, each with the width equal to one purusa and north-south length equal to one purusa and one aratni

Area of the body=2x2=4 sq purusas

Area of the two wings=$1x1^1/_5x2=22/5$ sq purusas

Area of the tail=$1x1^1/_{10}=1^1/_{10}$ sq purusas

Total area = $7^1/_2$ sq purusas

First, the body of the caturasra syena citi is constructed, by obtaining the square of the sides one purusa long with the fifth method of construction of a square (as in age no)

71 ĀŚS 17-21,9-1-11, 13-17

Indological Truths

Draw three squares, in contact with each other, by repeating this procedure in the clockwise direction A square of the sides two purusas long and of the area of four sq purusas is obtained This is the body of the caturasra śyena citi

Draw another square of the sides one purusa long by repeating the above procedure It is in contact with the southern side of the square representing the body Its north-south length is increased by one aratni A rectangle of the length of one purusa and one aratni and the width of one purusa is obtained This is the south wing Repeating the procedure draw the north wing

Draw a square of the sides one purusa long in contact with the western side of the body Increase the east-west length by one vitasti A rectangle of the length of one purusa and one vitasti and the width of one purusa is obtained This is the tail of the śyena

Āpastamba (10-1-3) has given greater details in the measurement of the fire altar of rectilinear śyena citi Bricks used in the construction is described by Āpastamba is slight different than Baudhāyana They are-

B_1 - one-fifth (of a purusa) pañcamabhāgīya, pañcami - 24x24 ang

B_2 - one-fifth with half, adhyardhā pañcami - 30x24 ang

B_3 - half of one-fifth, ardhāof pañcami - 24x12 ang

B_4 - quarter of one-fifth prādeśa - 12x12 ang

In the placement of bricks, 10 bricks longer by half (i e 36 ang x 24 ang) and turned towards west are placed on the eastside of the body (ātman), 10 (of them) turned towards east on the westside (of the body), 5 (of them) at each end of the two wings, 5 (of them) at both junctions of the wings (with the body) such that half of the bricks (i e the added half 12 ang of the adhyardhā) lie in the wings, and 5 bricks turned towards north and south on both sides of the tail After placing bricks of side equal to 1 prādeśa in the tail, all the (remaining) space of the fire-altar is to be covered with bricks of side equal to one-fifth) The number (of 166 bricks) is to be completed (to make 200) with bricks of side equal to one-fifteenth (of a purusa)[72]

72 ĀŚS 10 1-8, 10 1-9-16

Indological Truths

Indological Truths

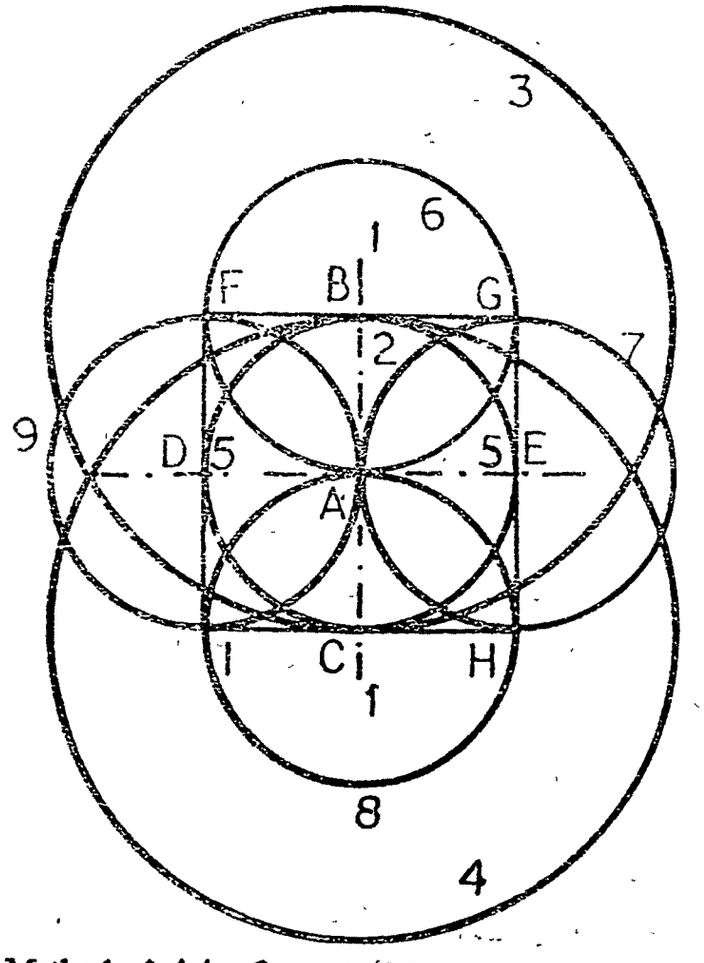

Fig. 1 Method of giving Layout of the Body of a Śyena Citi.

If we compare BŚS and ĀŚS no of bricks is different in these two Śulbasūtras It can be shown as follows

Parts of the Citi	Brick Types				Total	Brick Types				Total
	Baudhāyana					Āpastamba				
	A1	A2	B3	B4		B1	B2	B3	B4	
Body (including bricks at the junctions)	100				100	60	30			90
Wings	48		24		72	40	10			50
Tail	12	8	6	2	28	10	10	4(2)	2(6)	26(28)
Total	160	8	30	2	**200**	110	50	4(2)	2(6)	

(ii) Caturasra śyena citi (type II) - according to Ā.Ś.S. (See the diagram - 51)

The layout of the citi is identical with the one described earlier

Arrangement of bricks [73]

The bricks of the sizes 30x30, 24x24, 20x20, 15x15, 12x12 and 10x10 angulas are fabricated These are all square-shaped bricks

Arrangement of Bricks in the first layer [74]

Body At each corner place four bricks of 15x15 angulas Place 24x24 ang size bricks in that width of the body, at the two ends of which are the wings The remaining area is to be filled with the bricks of 30x30 angulas

Wings At the ends of the wings place the bricks of 15x15 angulas At the junction between the body and the wings place these bricks in such a way that six angulas is filled with bricks of 30x30 angulas

Tail Place 12x12 angulas size bricks at the south-west and the north-west corners of the tail The remaining area is to be filled with 30x30 angulas size bricks

73 ĀŚS 11 1-19

74 ĀSS 11 9-14

Indological Truths

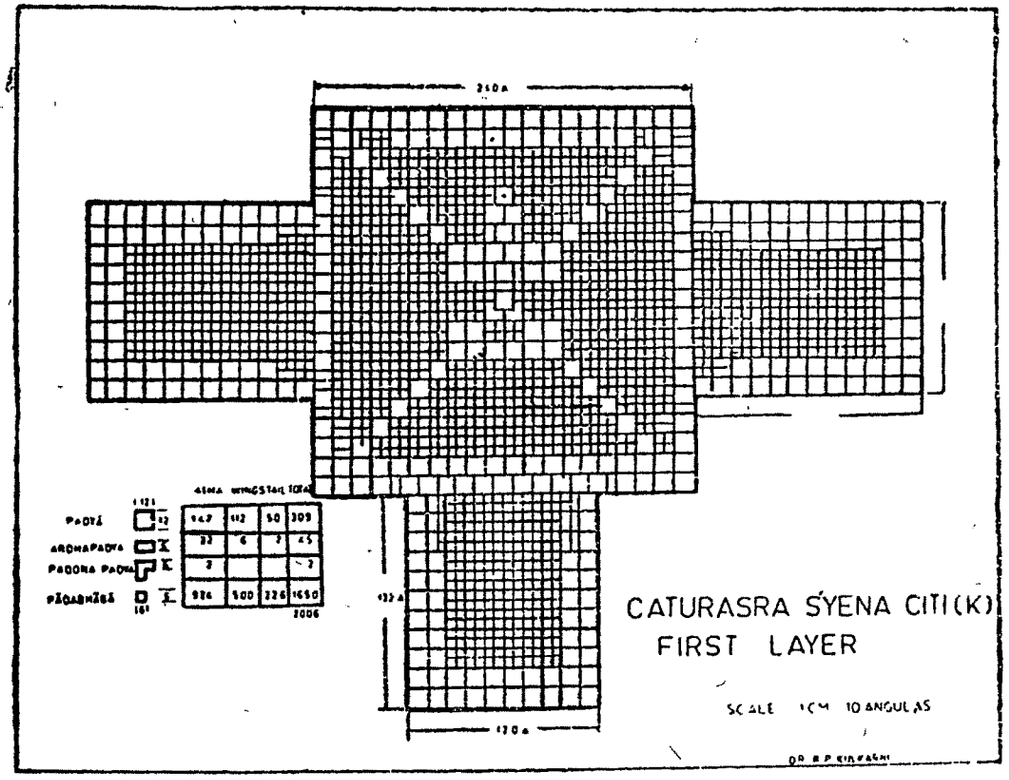

Fig. A – Caturasra Śyena Citi, First Layer

Indological Truths

Bricks equal to one-fourth purusa in size are to be used for making the total number equal to 200 It is to be noted that ten bricks of 12x12 ang size are required to be placed in the body is shown in the fig

Arrangement of Bricks in the second layer [75]

At the junction between the body and the tail bricks of 24x24 angulas size are to be so placed that half of their length is within the body and another half is within the tail Near them in the body, are to be placed 14 bricks of 12x12 angulas size The remaining area of the citi is to be constructed with the bricks 24x24 angulas in size The bricks one-fourth purusa in size are to be used to make the total number of bricks equal to 200

Caturasra śyena citi according to Kātyāyana: (See the diagram - 52a, 52b, 52c)

Kātyāyana Śulbasūtra[76] gives information only Caturasra śyena citi, i e of its layout and of arrangement of bricks for its construction It has ot given information about any other citis although they are mentioned

The arrangement of bricks[77] in Caturasra śyena citi does not follow the rule that the number of bricks in it shall be 200 per layer and the total number of bricks in all the five layers shall be 1000 Here not only the number of bricks per layer is of the order of nearly 2000 but the arrangement of bricks in each layer is different

Dimensions of citi are same as in the Baudhāyana and Āpastamba the method of giving layout of śyena citi

Take a cord of two purusa length Join its ends (1 & 2) the mid-point of the cord is obtained Join two ends of the cord (1 & 2) The mid point of the cord is obtained Join two ends of the cord to the mid-point (3) The cord is thus divided into four equal parts, each of one half purusa length Marks 4 and 5 are obtained Make a mark (7) at the distance of one fifth purusa from the mid-point (3) and

75 ĀŚS 11 15-18

76 KŚS 16 7 31-32, 16 8 1 21

77 Ibid 17 1 1-17, 11-12

Indological Truths

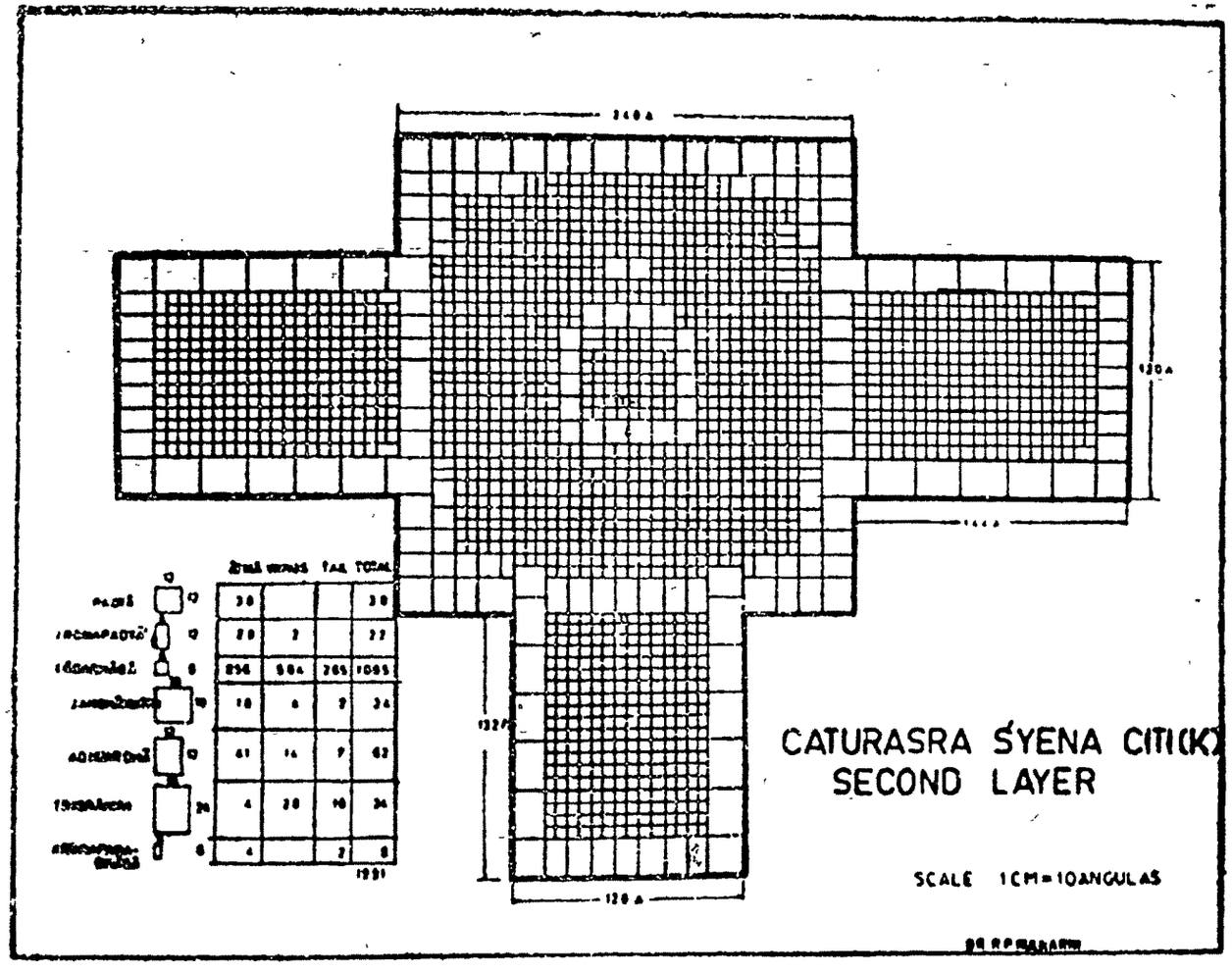

Fig. B Caturasra Śyena Citi, Second Layer

Indological Truths

towards the west of it Put another mark (6) at the distance of one-half aratni, this too towards the west, from the mid-point (3)

The centre line of the Mahāvedi is already drawn The eastern border of the citi is at the distance of one pada from the centre of the pit for yūpa[78] Place the cord on the centre line so that mark (1) shall be at a distance of one pada from the centre of the pit of yūpa Hammer pegs where marked 1, 2, 3 and 4 are located on the centre line Fastened the ends of the cord to pegs 4 and 5 and stretch the cord towards the south by holding the mid-mark (3) The place at which the mid-mark is located, is marked on the ground (N1) Position the cord along peg (3) and mark N1 so that in end mark 1 shall be at peg (3) Hammer a peg (6) where the mid-mark is located along the cord This is the mid-point of the southern border of ātman of the citi Fasten one end of the cord to peg (1) another to peg (6) and then stretch the cord towards the south (i e towards the south-east) by holding the mid-mark Hammer peg (7) where mid-mark is located This is the south-east corner (or the southern ams (a) of ātman Hammer a peg (8) where the mark (5) on the cord is located along the line joining pegs (16) and (7) Peg (8) is located at the centre of pegs (6) and (7) Repeat the procedure towards the west and hammer pege (9) and (10) giving the south-east corner and the mid-point between the pegs (6) and (9) respectively Repeating the procedure on north side, the north-east and the north-west corners of ātman are located

Fasten the ends of the cord to pegs (8) and (10) and stretch the cord towards the south by holding it at its mid-point Put a mark N2 on the ground where the mid-point is located Fasten one end of the cord to peg (8) and stretch it towards the south by holding the mark at the distance of $1^1/_5$ purusa Fasten the other end of the cord to the peg (12) and stretch it towards the east by holding it at a $^1/_2$ purusa mark The point on the ground where both these marks are simulteneously brought is to be marked by a peg (13) This is the south-east corner of the south wing is located

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78 पश्चाद्यूपावद्यात्पादमात्रे चित्यस्य । KŚS

Indological Truths

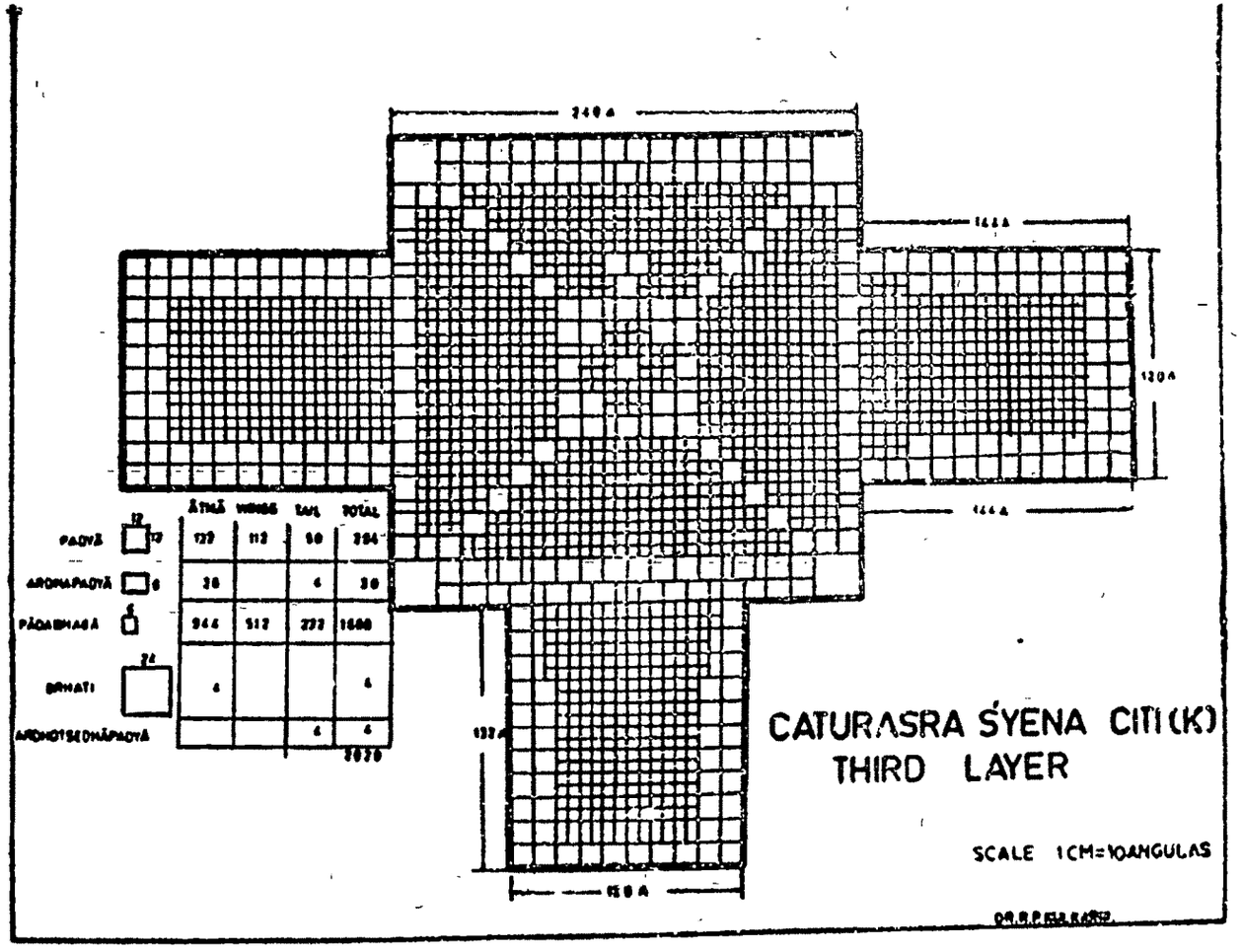


Fig. C Caturasra Syena Citi, Third Layer

Indological Truths

Repeat this procedure on the north side and give the layout for repeating the same procedure, the layout of the tail is to be given [79]

Sizes of bricks

There are fourteen kinds of bricks- (i) Brhatī=24x24 ang (ii) Ardhabrhatī=24x12 ang (iii) Pādyā=12x12 ang (iv) Ardhapādyā=12x6 ang (v) Pādonapādya=L-shaped brick, (vi) Janghāmātri=18x18 ang (vii) Adhyārdhā=18x12 ang (viii) Ardhotsedhapādya=12x12 ang (ix) Ardhotesedha-ardhapādyā=12x6 ang (x) Padabhāgā=6x6 ang (xi) Trigāhinī=24x18 ang (xii) Ardhapadabhāga=6x3 ang (xiii) Caturbhāga=3x3 ang (xiv) Vakra Height of all the bricks is 6 or 4 angulas

Arrangement of bricks in five layers:

The height of all the bricks is 6 or 4 angulas Arrangement of bricks is shown for all the five layers, in accompanying drawing in the figures

It is further stated that the agniksetra is to be surrounded by a cord and along the alignment of the cord a shallow pit (parikhā) around the citi is to be dug In this shallow pit 261 gravels or (261x94=) 355 or 264 gravels are to be entrenched, their long sides being kept vertical These gravels are supposed to act as a support against the spread of the bricks of the citi

1 The First layer (Cau Śy Citi)

Bricks	Padyā 12x12A	Ardhapadyā 12x6A	Pādonapādyā L shaped	Pādabhāga
Ātmā	147	32	2	924
Wings	112	6	–	500
Tail	50	7	–	226
Sum	309	45	2	1650 =2006

79 द्वि पुरुषा रज्जुं । मत्वोभयतः पाशा मध्ये लक्षणम् ।। अभितोऽर्द्ध पुरुषयोश्च । मध्यमात्पुरुषपञ्चमे अर्द्धे च । अनुपृष्ट्यामायमस्य पाशयोः शङ्कू मध्ये अर्धपुरुषयोश्च ।। पाशौ उन्मुच्यार्द्धपुरुषीययोः प्रतिमुच्य दक्षिणाऽयम्य मध्यमे नितोदं करोति । उन्मुच्य पाशावेक मध्यमे प्रतिमुच्य पूर्वार्द्धे च दक्षिणाऽयम्य मध्यमे शङ्कुः । तस्मिन् पाश प्रतिमुच्य पूर्वार्द्धे च दक्षिणाऽऽयम्य मध्यमे शङ्कुः । पश्चादर्द्धपुरुषे च । उन्मुच्य पूर्वाद्ध्यात् पश्चार्द्धे प्रतिमुच्य दक्षिणाऽऽयम्य मध्यमे शङ्कुः । अभितोऽर्द्धपुरुषयोश्च । एवमुत्तरोऽन्तः । दक्षिणे पार्श्वे पूर्ववदायम्य पञ्चमभागीयार्द्धपुरुषीययोः सन्निपात्य

Indological Truths

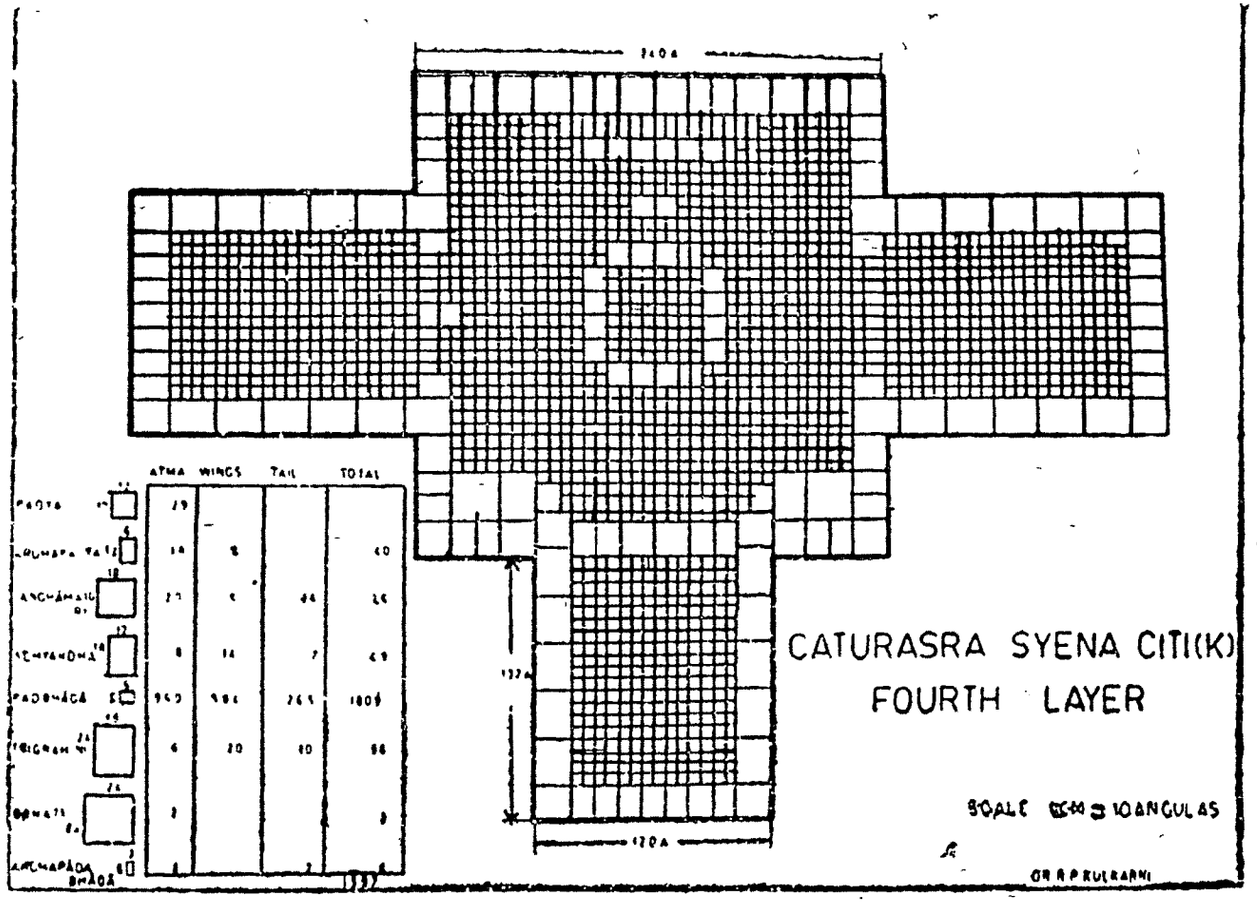


Fig. D Caturasra Śyena Citi, Fourth Layer Fig 52

Indological Truths

2 The Second layer

Bricks	Padyā 12x12A	Ardhpadyā 12x6A	Jaṅghāmātrı 18x12A	Adhyardhā 18x12A	Trıgrāhnı 24x18A	Padabhāgā 6x6A	Ardha-padabhāga 6x3A
Ātmā	38	20	18	41	4	956	4
Wıngs	–	2	4	14	20	584	–
Taıl	–	–	2	7	10	265	2
Sum	38	22	24	62	34	1805	6

Sum = 1991

3 The Thırd layer

Bricks	Padyā 12x12A	Ardhapadyā 12x6A	Padabhāgā 6x6A	Bṛhatī 24x24A	Ardhatesedha 12x12A
Ātmā	132	26	944	4	4
Wıngs	112	–	512	–	–
Taıl	50	4	232	–	–
Sum	294	30	1688	4	4

Sum = 2020

4 The Fourth layer

Brıcks	Padyā 12x12A	Ardha Padyā 12x6A	Jaṅghā mātrı 18x18A	Adhya-rdha 18x12A	Padabugh 6x6A	Trıgrāhını 24x18A	Bṛhatī 24x24A	Ardha Padabhagı 6x3A
Ātmā	29	38	20	28	960	6	2	4
Wıngs	–	2	4	14	584	20	–	–
Taıl	–	–	2	7	265	10	–	2
Sum	29	40	26	49	1809	36	2	6

Sum = 1997

Dस्मिन् शङ्कुः । एव पश्चात् । एवमुत्तरः पक्षः तथा पुच्छं वितस्त्या । इच्छान्पक्षपुच्छाप्ययेषु चतुरङ्गुल सकर्षति विकर्षत्यन्ते । पञ्चारत्निः पुरुषो दशपदो द्वादशाङ्गुल पद प्रक्रमस्त्रिपदः समविभक्तस्य ॥ K ŚS 16-8-1-18

80 MŚS 10 2 1 1-4, 10 2 2, 2 3 7 9

Indological Truths

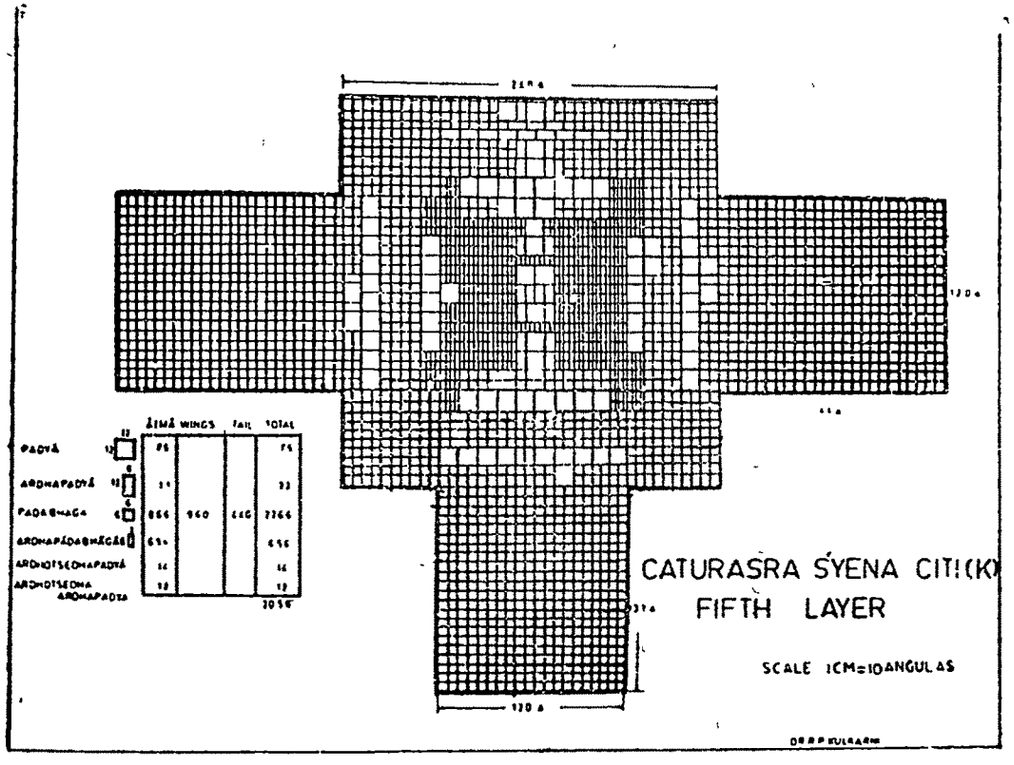
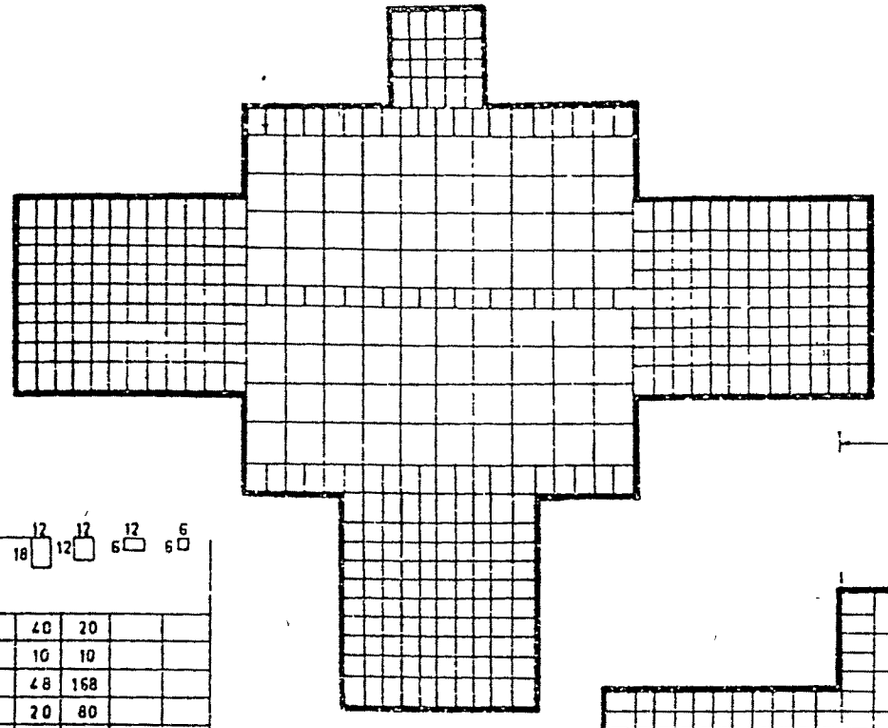
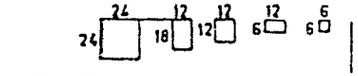


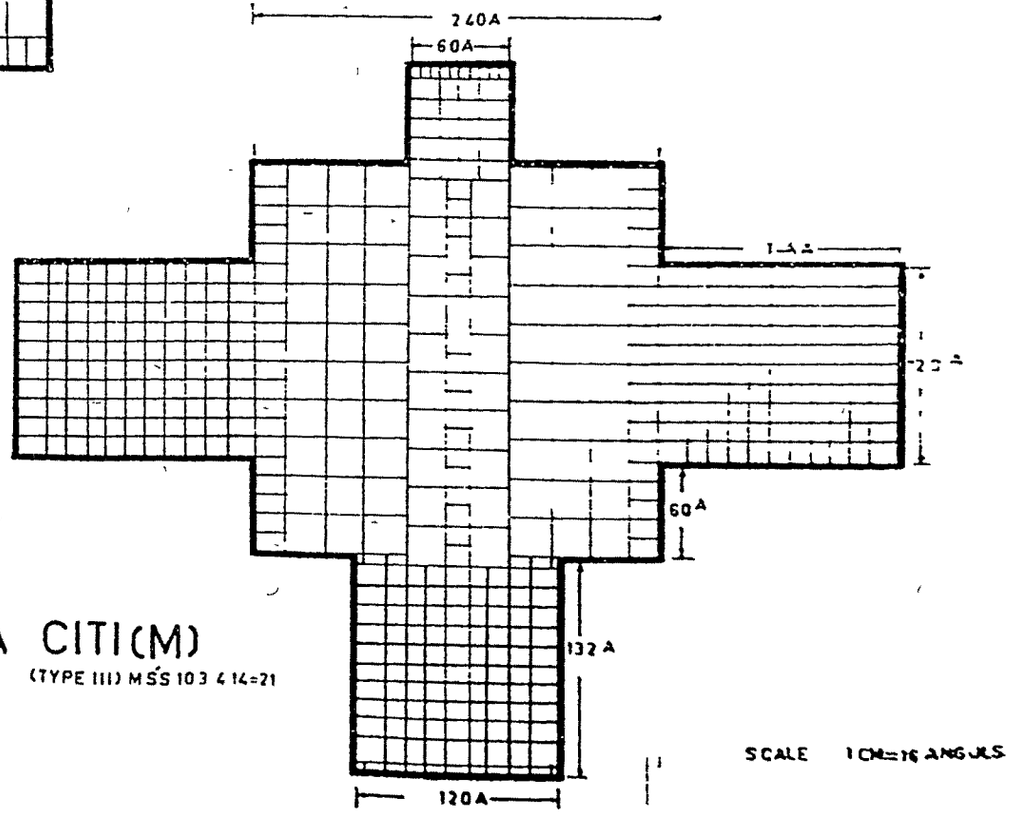
Fig. E Caturasra Śyena Citi, Fifth Layer

Indological Truths





I LAYER						
ATMA	80	40	20			
HEAD		10	10			
WINGS		48	168			
TAIL		20	80			
TOTAL	80	118	278			476
II LAYER						
ATMA	80	42	22			
HEAD		8	8			10
WINGS		40	180			
TAIL		20	70	13	4	
TOTAL	80	110	280	13	14	497



CATURASRA ŚYENA CITI(M)

(TYPE III) MŚS 10 3 4 14=21

Fig 53 (a) ~~(b) (c)~~

Indological Truths

5 The Fifth layer

Bricks	Padyā 12x12A	Ardhapadyā 12x6A	Padabhāgā 6x6A	Ardha-padabhaga 6x3A	Ardhatse-dhapadyā 12x12A	Ardhotesedha ardhapadyā
Ātmā	75	33	866	656	14	12
Wings	–	–	960	–	–	–
Tail	–	–	440	–	–	–
Sum	75	33	2266	656	14	12

Sum = 3056

Mānava Śulbasūtra[80] have given three types of construction of Caturasra Śyena Cit

Arrangement of Bricks:

Sizes of Bricks

The bricks used are square and rectangular in shape and are of size 30x30, 18x12, 12x12 and 12x6 angulas Their height is six angulas unlike that prescribed Baudhāyana which is 32/5 angulas

Arrangement of Bricks in First layer:

Head The head is a square of 60x60 angulas Four bricks of 30x30 angulas could be accomodated But, in order to obtain 200 bricks per layer, only two bricks of 30x30 angulas are placed near the eastern border of the head and 10 bricks of 12x12 ang and five of 12x6 ang are placed

Body The body is square in shape and the length of its sides is 240 angulas 8x8=64 bricks of 30x30 ang size may be placed The central four bricks are removed and the gap is filled with

Wings The length and width of the wings are 144 angulas and 120 angulas respectively Twenty bricks of 12x12 ang are to be placed in two columns in the wing in the portion near the body The remaining square of 120x120 angulas is filled with 16 bricks of 30x30 angulas Repeat the arrangement at the other wing

Indological Truths

Tail Put a row of ten bricks of 12x12 angulas size in that portion of the tail which is near the body The remaining area of 120x120 sq angulas is filled with 16 bricks of 30x30 angulas

Second Layer At the eastern border of the head, five bricks of 12x12 angulas are placed The length from the east side of the head to the west side of the tail is 432 angulas The bricks of different sizes are so arranged that their total length is equal to 432 angulas Now 12+30x4+18+30x4+6+12+30x4+12x2=432 angulas Similarly, the distance from the sothern border of the south wing to the northern border of the northern wing is 528 angulas The arrangement of bricks in the third and fifth layer is identical to that of first layer and fourth layer to the second layer

Two bamboo rods are taken, one measuring 120 angulas (one purusa) in length, the other 144 angulas In the second bamboo rod marks are given at a distance of 120 angulas 132 angulas and 144 angulas from one end Two middle marks are given in these two rods at a distance of 60 angulas from the same ends Then a pañcangi cord is formed in the following way A cord AB of length 2 purusas (240 ang) is taken and three marks are given one at the middle of the cord C and one each at the middle of two halves, i e at D and E The cord is fixed by two poles at its eastern and A and the western and B, poles are likewise fixed at C, D and E The two bamboo rods are then stretched towards south from D and E respectively so as to meet at F, 120 ang from the end of each The first bamboo rod is held over C so as to obtain G at 120 ang from C Now the second bamboo rod is stretched from pole A towards south and the final rod from G towards east so as to meet at H, 120 ang from the end of each rod H is the south-eastern corner of the ātma Likewise, the north-eastern corner I and the two western corners J and K of the square body are fixed The area of the body is thus 240 sq ang or 4 sq purusa To construct the northern wing poles are fixed at L and M, the middle points of the two halves of the southern side HK By stretching the two bamboo rods from L and M towards south the point N where they meet at a distance of 120 ang from the end is determined The second bamboo rod is now held over GN and the point O 144 ang

Indological Truths

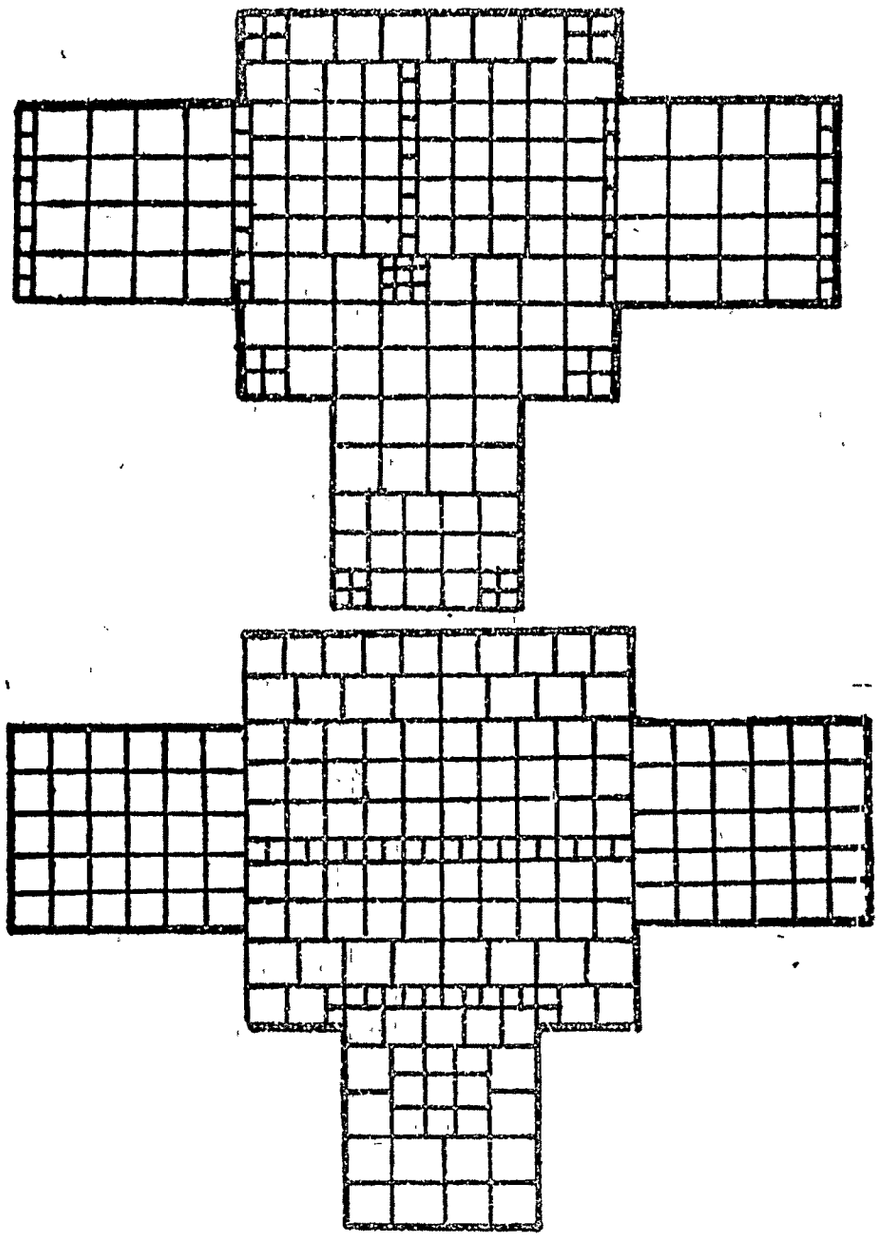


Fig. 3 Caturarsa Syena Citi (Type II)

Indological Truths

from L and the first rod from O the point P is fixed and likewise the point Q, so that the rectangle L P Q M constitutes the southern wing Likewise, the northern wing is formed The area of each wing measures 120x144 sq ang or $1^1/_5$ sq pu and that of two wings $2^2/_3$ sq pu

Second type of Caturasra Śyenaciti [81]

The layout of the citi is identical to that of the Śyena citi

Arrangement of Bricks in the first layer:

The size of different bricks are same as given in Caturasra Śyena citi (type I) Five rectangular bricks of 18x12 angulas size are placed, oriented towards the north, on the south and the north sides oriented towards the north, on the south and the north sides of the head 20 bricks of this size are placed, oriented towards the east, near the eastern and the western borders of the body 12 bricks of this very size are placed, again oriented towards the east and along the eastern and the western borders of both the wings The remaining area of the citi is constructed by using the bricks of 12x12 ang and 30x30 ang as shown in the figure - 53

The wealth of the wing is 120 angulas The width of 36 ang is occupied by the rectangular bricks as given above In the remaining width of 84 angulas, the bricks of 30x30 angulas cannot be accommodated Hence one has to arrange the bricks along the width of the wings as shown in the drawing, i e from the east to the west, first 18 angulas of 12x18 angulas bricks, then 30 angulas of 30x30 angulas, bricks then two bricks of 12x12 angulas size and then again bricks of 30x30 angulas size and 18x12 angulas size are placed one after the other The total distance is 120 angulas The rule of the symmetrical arrangement is also observed Similar reasoning is applied in arranging square-shaped bricks in the body The arrangement of bricks in the tail is obvious The condition that the number of bricks should be 200 per layer cannot be observed

81 MŚS 10 2 2-11-13

Indological Truths

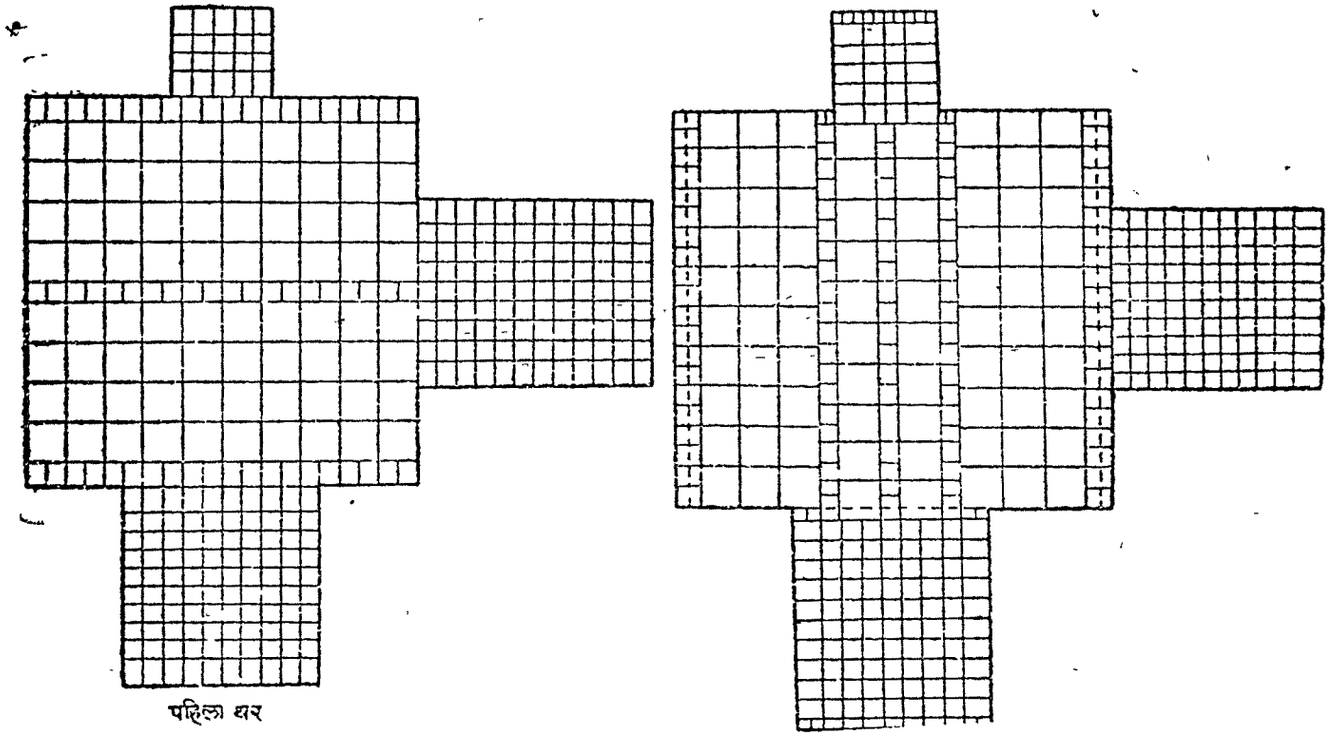


Diagram 54 Arrangement of bricks in First layer
Caturasra Syena Citi (Type II)

Indological Truths

Arrangement of Bricks in the second layer

The rectangular bricks of 18x12 angulas size are placed in the head, oriented towards the east, near its eastern and western borders These bricks are placed oriented towards the south at the southern and the northern borders of the body and of the tail There are 10 such bricks in the head, 40 in the body and 22 in the tail

The remaining area is filled with square-shaped bricks as shown in the figure Two columns of bricks of 12x12 angulas size are placed in addition to the six columns of 30x30 angulas size The arrangement of bricks is such that the joints are broken and the bricks are symmetrically placed The total number of bricks in this layer is 269 while in the first layer it is 306 Thus the number of bricks is more than 200 in each layer and not same in different layers

The arrangement of bricks in the third and fifth layer is identical to that of the first layer and the arrangement of bricks in the fourth layer to that of the second layer

Caturasra Śyena Citi (Type III)[82] (See the diagram - 54)

The layout of the citi is identical to the citi of type I

Arrangement of bricks in the First layer

The largest size of the square-shaped brick is one-fifth of the purusa measure, i e 24x24 angulas Other sizes of bricks are 18x12, 12x12, 12x6 and 6x6 angulas

Five rectangular bricks of 18x12 angulas size are placed turned towards the east near the eastern and western borders of the head, 20 such bricks are placed near the eastern and the western borders of the body and 12 are similarly placed at the eastern and western borders of the wings Ten bricks of this size are placed, oriented towards the east near the eastern and the western borders of the tail The remaining area of the citi is filled up with square-shaped bricks

Arrangement of Bricks in the Second layer

Rectangular bricks are placed in the head, body, wings and also in the tail, all

82 MŚS 10 3 4 14-22

Indological Truths

oriented towards the south and along the southern and northern borders of each part The remaining area is constructed by using square shaped bricks B rectangular bricks of 12x6 angulas size are used in addition in the tail The defects in this arrangement of bricks is that the joints along the junction between the wings and the body are not broken

Alternate Arrangement

This arrangement of bricks is as shown in the figure The suggestion regarding the arrangement of rectangular bricks of 18x12 angulas size is followed here also But instead of providing the bricks 18x12 angulas near the southern and northern borders of each wing, they are placed near one border only, i e those in the southern wing are placed near the southern border and those in the northern wing are placed near the northern bofder only Square bricks of 12x12 angulas size are placed at the junction of the body and wings such that six angulas width of these bricks is inside the wings and six angulas width is inside the body The bricks near the southern and the northern border of the body, beyond the junction of the body and the wings, are of rectangular shape being of 18x12 angulas size By this arrangement the joints in the junction between the body and the wings of alternate layers are broken The other arrangement of the bricks is similar to the previous one

Bricks	**Square 24x24A**	**Rectangular 18x12A**	**Square 12x12A**	**Rectangular 12x6A**	**Square 6x6A**
First layer					
Head	–	10	10	–	–
Ātmā	80	40	20	–	–
Wings	–	48	168	–	8
Tail	–	20	80	–	12
Sum	80	118	278	–	=476

Indological Truths

Bricks	Square 24x24A	Rectangular 18x12A	Square 12x12A	Rectangular 12x6A	Square 6x6A
Second layer					
Head	–	8	8	–	10
Ātmā	80	42	22	–	–
Wings	–	40	180	–	–
Tail	–	20	70	13	4
Sum	80	110	280	13	14 =497

Conclusion :

In all types of Caturasra Śyena cits, I would like to conclude that, the Śulbasūtrakāras knowing the layout and construction of a rectilinear figures in different ways In modern days, giving layout and construction of a structure of these kinds are done by engineers Along with this, they studied geometry as a separate subject for this purpose But Śulbasuātrakāras did not do so Area of each citi is standard and it is $7\frac{1}{2}$ sq purusa but constructional methods are different and size of bricks, arrangement of bricks and total number of bricks in every layer may also different This is not a simple way of construction Therefore, the technology of preparation of bricks, specification of bricks and the arrangement of bricks was developed at the time of Śulbasūtrakāra period

Vakrapakṣa Vyastapuccha Śyena citi:

This is another type of Śyena citi 'Vakrapaksa' means falcon with 'curved wings' and Vyastapuccha means extended tails Thus, this type of Śyenaciti looks like a shape of a real falcon bird with head, body and tail with a wonderful construction of drawing The technology of construction and arrangement of bricks have been more developed in this type, than the caturasra form I would like to discuss in detail now

Indological Truths

Fig 55

Indological Truths

Construction of Vakrapakṣa Vyastapuccha Śyena Citi:

(Fire altar in the form of a falcon with curved wings and extended tails)

This type of five altar is constructed more in the likeness of a falcon To achieve this the two wings are to be curved or bent and the tail is to be extended, i e spread out The body (or called ātman) itself should be cut out at its four corners, and there should be a head The end of each wing is serrated to give it the appearance of being provided with feathers The laying of this type of fire-altar on the past of these who desire heaven has been greatly emphasized in the Brāhmanas

The Śatapatha Brāhmanas[83] teaches us how to bend the wings of the falcon in order to construct that variety of the fire-altar, known as the Vakrapaksa Śyena citi

"He contracts the inner extremity (of the southern wing) inside on both sides only by four angulas onward on both sides he expands the outer extremity Thus by as much he contracts, by so much he expands, certainly, for that, be neither exceeds (the proper size of the wing) nor makes it too small Similarly, he does for the tail, and in the same way, for the northern wing Then, he makes the land of the two wings For bents there are in the wings of a bird, the bents of the wings of a bird are by its one-third each by one-third of the wings inwards each the bents of the wings of the bird are He expands (each of the wings) on the front just by four angulas, he contracts at the back by four angulas Thus by as much he expands by so much he contracts and so he neither exceeds, nor makes it too small "[84]

Śulbasūtras explain falcon fire-altar with curved wings and extended tail in various types In first type, Baudhāyana has given the construction with full description

For building a fire-altar of this shape rectilinear bricks alone would not do Bricks of other geometrical shapes are needed, which are first delt with In the first

83 Ś Br X 2 1 4

84 Ś Br X 2 1 4-5

Indological Truths

type Baudhāyana has given the following five types of bricks have been prescribed and it may be listed as follows

B_1 - one-fourth (caturthi) square brick 30x30 sq angulas, i e a square whose side AB is 1/4 pu or 30 angulas

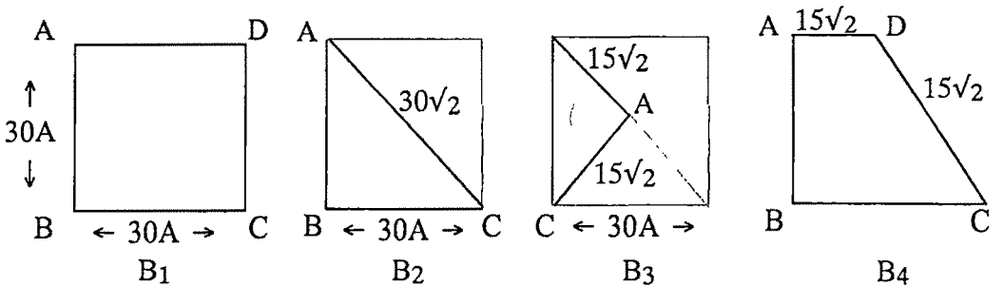
B_2 - half brick (ardhā) obtained by cutting the one-fourth square brick diagonally, each of 2 sides AB, AC equal 30 angulas and the diagonally side or hypoteneuse BC 30 2 angulas

B_3 - quarter brick (pādya) obtained by cutting the one-fourth brick diagonally, each 2 sides AB, AC equals 15 2 ang and hypoteneuse BC 30 angulas

B_4 - four-sided quarter brick (caturasra-pādya) of which CD equals $^{15}/_2$ angulas BC 15 angulas, AB $22^1/_2$ angulas, AD 15 2 angulas 1 pada being 15 angulas, the measures are given here in angulas, padasavisesa means the diagonal of a square of side 1 pada or 15 angulas or the hypoteneuse of a right isosceles triangle of side 15 angulas, clearly, such a figure is obtained by joining the rectangle EBCD with the isosceles right triangle AED along the common side ED Its area is $\frac{15x15}{2} + \frac{15x15}{2}$ sq angulas = 15x15 sq angulas, the same as that of the quarter brick B_3

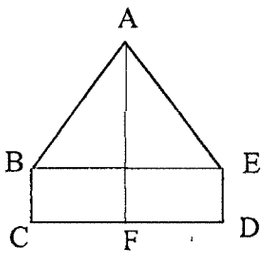
B_5 - half brick ABCDE obtained joining QB_4S along their common longest side AF, this is also called swan-beaked, hamsamukhi [85]

All bricks can be shown as follows-



85 BŚS 4-2-43

Indological Truths



B5

Layout of the Citi:[86]

The ātman is two purusas long (240 ang) and ten pādas broad (150 ang) Draw a square of sides of length of two purusas as described for the layout of the ātman of Caturasra Śyena Citi Decrease the width to 150 ang by measuring a distance of 7 ang from the centre line (prsthyā) on each side Thus a rectangle of 240 ang in length and 150 ang in width is obtained At the distance of $1^1/_2$ prakramas (45 ang) towards the north form the south-east corner of the oblong representing the ātman. a mark is to be made A mark is to be at the distance of 45 ang from the south-east corner towards the west Stretch a cord over these two marks and cut off the corners Other corners are to be cut off likewise This completes the layout of the ātman

Area of the head = $60x52^1/_2+^1/_2x60x30$ = 4050 sq ang

Area of the body = $240x240-4x^1/_2x45x45$ = 31950 sq ang

Area of the wings = 2 ($150x180+^1/_2x5x30x30$) = 58400 sq ang

Area of the tail = $^1/_2$ (60+240)x90 = 13500 sq ang

Total area = 108000 sq ang = $7^1/_2$ sq purusa

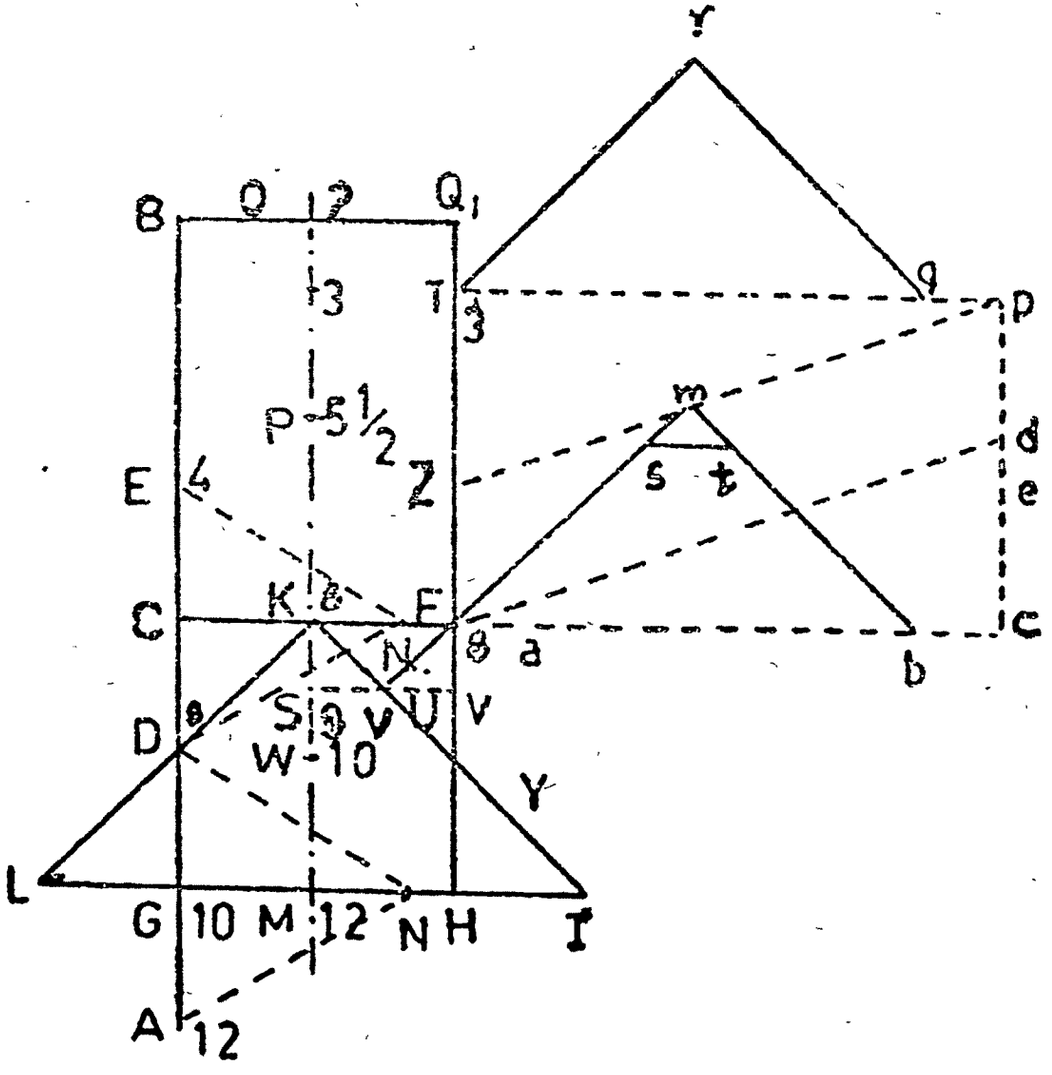
Areas and shapes of different parts of the fire-altar:

To construct the fire-altar in this shape, Baudhāyana has given two methods while, Āpastamba gives the construction of two other types Baudhāyana's construction of first type is in following way

Body, head, tail are the three main parts of a falcon and it is measured out The body is 2 purusa (240 angulas) in length by 10 padas (150 angulas) in breadth From its south-eastern corner towards north a mark is given at a distance of $1^1/_2$

86 BŚS 4-8-25

Indological Truths



Indological Truths

prakrama (45 angulas) the same (is done) towards west By stretching a cord over these (two marks) the south-eastern) corner is to be cut off Thereby it is explained the cutting off other (three) corners This makes the body

The head is of $5^1/_2$ padas ($82^1/_2$ angulas) in length by $^1/_2$ purusa (60 angulas) in breadth The two eastern corners of it are cut off with 1 prakrama (30 angulas)

The tail measures 6 padas (90 angulas) in the east-west and 2 purusas (240 angulas) in the south-north direction The two eastern corners of it are cut off with 3 prakramas (90 angulas) each The (southern) wing is of 12 padas (180 angulas) in length (along north-south) and 10 padas (150 angulas) in breadth (along east-west) A pole is fixed at a distance of 6 padas (90 angulas) to the east from the middle (of its western side) and at each of the two south-western corners (of the rectangular wing) With a cord (stretching between these three poles, a triangular area) is to be enclosed The (triangular) area enclosed by the cord is to be cut off and placed on the eastern side (of the wing) (with its vertex) pointing towards east This is the bending (of the wing) Thereby the bending of the northern wing is explained [87]

At the end of each wing 5 squares of side equal to 1 prakrama (30 angulas) are laid (in a row) so as to be in contact with each other, all of them are interested diagonally in the downward direction (by joining the north-east corner to the south-east) and a half portion is removed (from each square) These different parts of the falcon with curved wings and extended tail may be shown in figure - 55

Arrangement of Bricks:[88]

Prepare square bricks of length equal to the fourth part of a purusa (30x30 ang) There are called 'caturthi' bricks - triangular bricks of half and one fourth the area of the caturthi bricks are also fabricated For preparing these bricks the division of the original brick, caturthi, is always to be made following the diagonals The quarter (pāda) brick (having area one-fourth of that of the caturthi brick) with four

87 BŚS 4-2-30-35

88 Ibid 4-26-36

Indological Truths

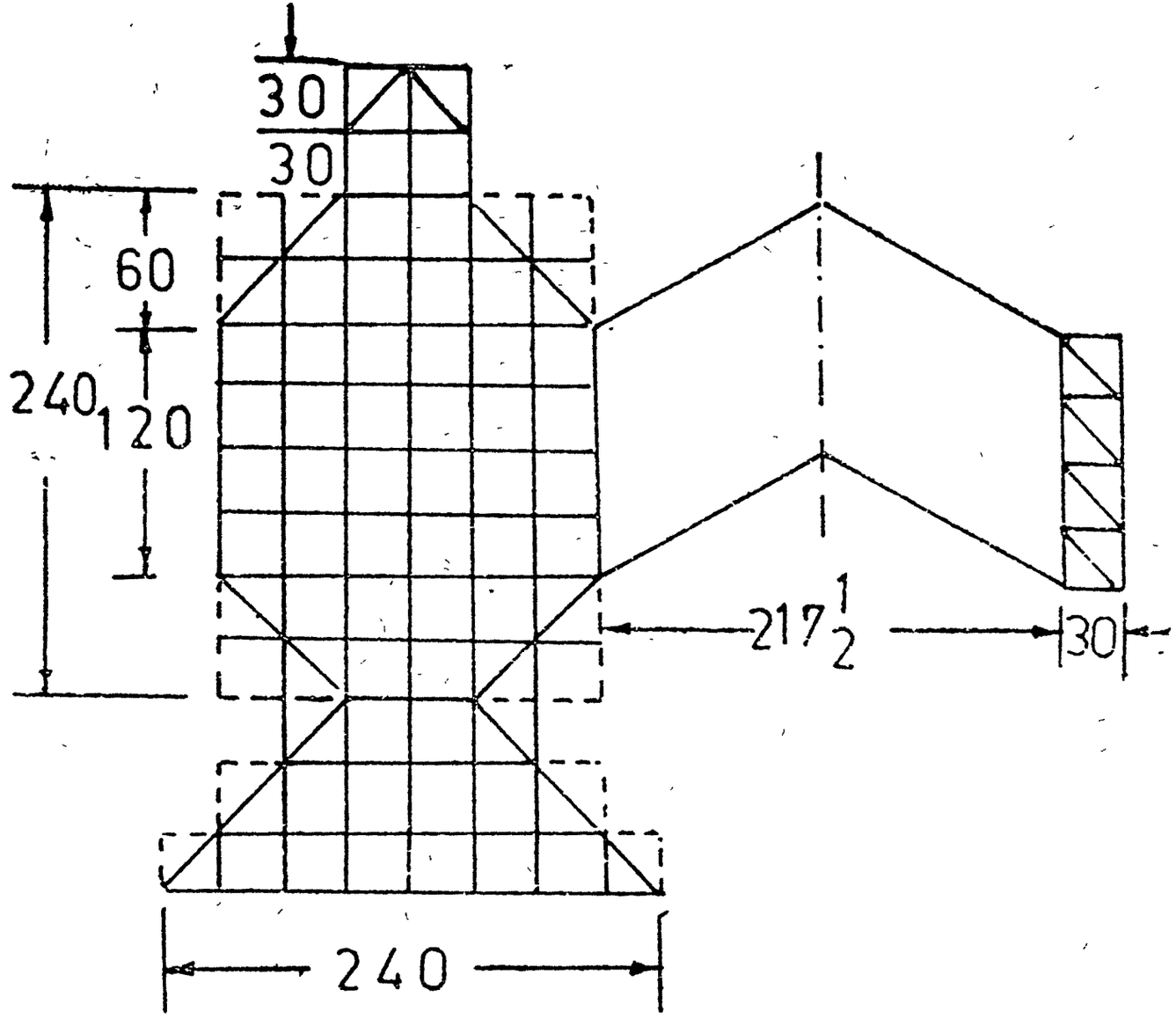


Fig. 12 Method of giving Layout of Śyena Citi

Indological Truths

sides having length half a pada ($7^1/_2$ ang), a pāda (15 ang), one pāda (21 ang - 7 tilas) are made Then a half brick (i e a brick with area equal to one half ofa caturthi brick) is to be formed putting together two of these four-cornered quarter bricks along their long sides This is called haṃsamukhi brick

The first layer A caturthi brick is to be placed there where the head is joined to ātman

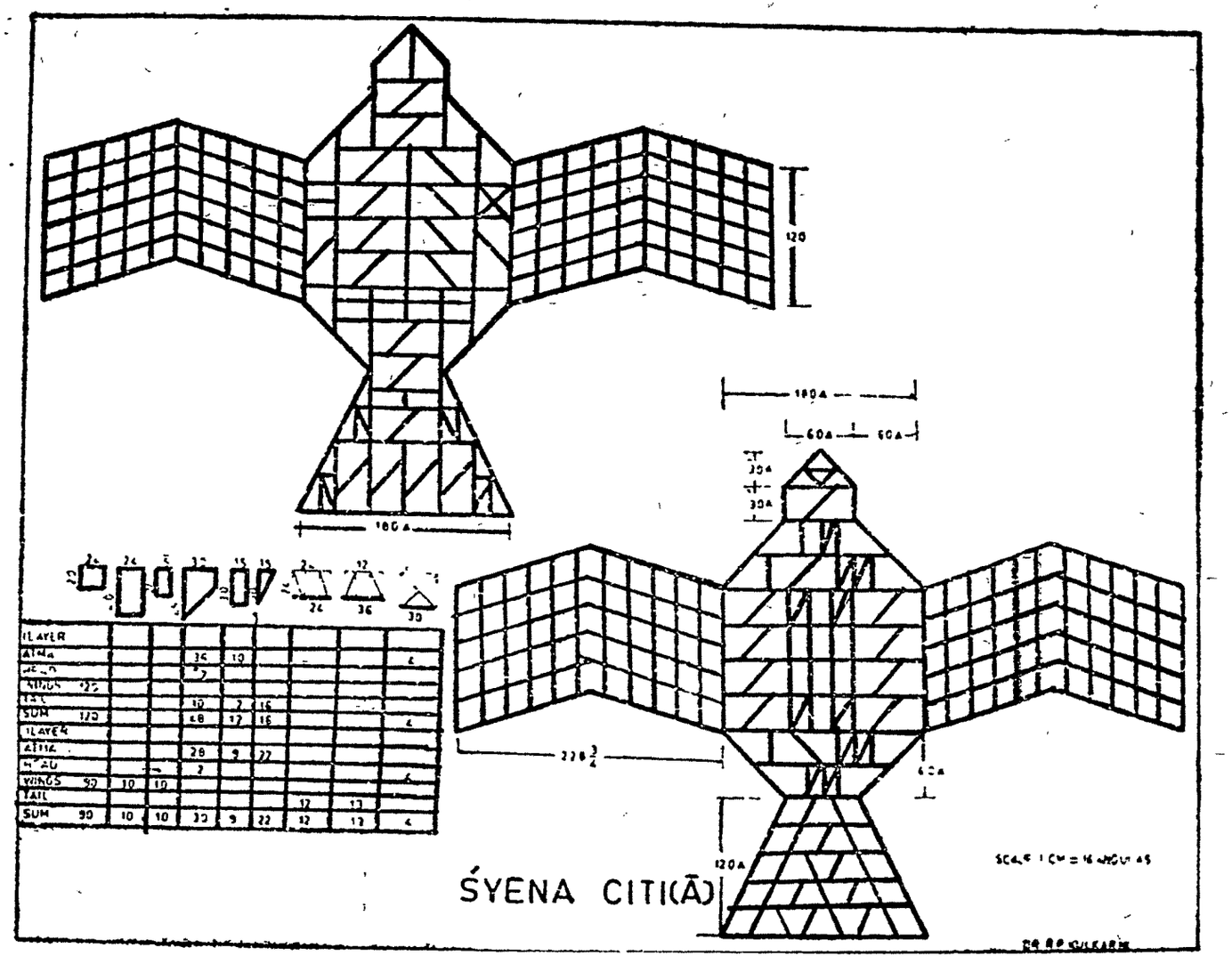
The head is five and half padas long ($82^1/_2$ ang) and half a purusa broad (60 ang) Draw a square of sides $82^1/_2$ ang long and then decrease its width to 60 ang by measuring a distance of 30 ang on both the sides from the centreline A rectangle of $82^1/_2$x60 ang is obtained The two eastern corners are to be cut off with one prakrama (30 ang) each It is to be seen that the tip of the pointed head is located at a distance of $7^1/_2$ ang from the centre of the pit meant for the yūpa

The east-west length of the tail is six padas (90 ang) The width of the tail at its eastern side is same as that of the length of the western side of the ātman (60 ang) The width of the tail at its western end is two purusas (240 ang) The two eastern corners of the oblong are to be cut off with 3 prakramas (90 ang) each But he has not given the procedure of giving this layout One of the methods would be to draw a square of 90 ang length, the eastern side of which coincides with western side of the ātman Extend the south-north lines on the eastern and the western side of the tail by 120 angulas (one purusas) from the centre-line on its both the sides and then cut off the corners as described above Another method would be to draw two squares each of 90 ang length on southern and northern side of the western border of the ātman and then draw an oblong of 90 angulas length and 240 ang width and then cut off the corners towards the east

The southern wing is of 12 padas in length and 10 padas in breadth A pole is fixed at a distance of 6 padas to the east from the middle and at each of the two south-western corners (of the rectangular wing)

Alternatively, 1 haṃsamukhi brick is to be placed at the eastern extremity of

Indological Truths



LAYER								
ATMA			36	10				4
WINGS 120			48	17	16			4
LAYER 4								
ATMA			28	9	22			
HEAD			2					4
WINGS 90	10	10						
TAIL						12	12	
SUM 90	10	10	30	9	22	12	12	4

Indological Truths

the head and 1 caturthi below it, to be flanked by 1 quarter brick on either side, 3 four sided quarter bricks are placed to the west of these two quarter bricks and on each side of the head

5 quarter bricks mutually joined with one another are to be placed to the west of the head on the eastern end of the body and the same to the east of the tail on the western end of the body Half bricks as well as quarter bricks are to be placed in the truncated parts [89]

Number and types of bricks used in different parts of the fire-altar is given in the table

Parts of the Citi	B_1	B_2	B_3	B_3	B_5	
Head	1		6	6	1	14
Body	30	6	10			46
Wings	30	62	16			108
Tail	8	4	20			32
Total	69	72	52	6	1	200

While Āpastamba, the placement of bricks in the first layer explained in different way

In the placement of bricks in the first layer 60 bricks of the first type turned towards north, are placed in each wing Along each side of the tail 8 bricks of the sixth type are placed in this way, three of them at the end of the tail with the body, 2 bricks of the fourth type partly type partly covering both the tail and the body are placed West of them are placed 2 bricks of the fifth class touching each other to edge The remaining space of the tail is covered by 10 bricks of the fourth type 8 bricks of this type, turned towards east and west, are placed in the four corners of the body The remaining space of the body is covered by 26 bricks of the fourth, 8 of the sixth and 4 of the fifth type In the head, 2 bricks of the fourth type partly

89 BŚS 10 10-13

Indological Truths

covering both the head and the body are placed and 2 of the same type turned towards east, above them This is formed the first layer of 200 bricks [90]

Arrangement of Bricks in the second layer:

Four hamsamukhis are to be combined with four triangular quarter bricks in such a way that they form together an oblong, this oblong is to be placed side ways on the spot of the "svayammātrnn" i e in the centre of the citi Two hamsamukhīs turned towards the west are to be placed there where ātman and the tail are joined in such a way that the half pāda is situated in the ātman To the west and both sides of these two hamsamukhīs, three triangular bricks are to be placed, their tops (right angles) turned towards the east

At the west side of the tail, 15 triangular quarter bricks joined with each other are to be placed In the feathers of the wing by turns two triangular quarter bricks and one half brick are to be placed, from the west towards the east

At the places where the ātman is joined to the wings and those places where something has been cut off, half bricks and quarter bricks are to be placed, the rest of the agni is to be covered by caturthis Use quarter and half bricks replacing caturthi bricks so that the total number of the bricks shall be 200 Thus the second layer of the citi is constructed

The arrangement of bricks followed for the construction of the first layer is to be used for the construction of the third and fifth layers The arrangement of the bricks in the second layer is to be followed for the construction of the fourth layer [91]

In Āpastamba Śulbasūtra, chapter 15, 16 and 17 deals with another type of falcon shaped curved wings and extended tail In this type the curving of the wing is to be done by pushing the west side upwards and east-side downwards The are of the fire altar is to be made seven fold with two aratnis and one pradeśa Here length of the wing is $9^1/_2$ aratnis and $^3/_4$ angulas The body is 2 purusas long and

90 ĀŚS 16-11 to 17-04

91 BŚS 4

Indological Truths

$1^1/_2$ purusas broad (i e 36000 sq angulas) The area of the head which is built out of 3 caturbhāgīyas, is 2700 sq ang or $^3/_{10}$ sq pu The area of the tail after the pradeśa portion is taken out is 14400 sq ang or 1 sq pu [92]

In brief it may be listed as follows

Wings

The total area of the citi = 108000 sq angulas

The area of the head = 2700 sq angulas

The area of the body = 36000 sq angulas

The area of the tail = 14400 sq angulas

The area of each wing = $^1/_2$ (108000-3100) = 27450 sq angulas

The east-west width of the wing is equal to 120 angulas The length of the rectangle representing the wing is, therefore, equal to $228^3/_4$ angulas According to Ā Ś.S 15 14, the length of the wing is $9^1/_2$ aratnis- 4 angulas, i e 224 angulas There is no mention of the feathers at the end of the wings

At the corners of the western border of the rectangle representing the wing, two pegs are placed The ends of a cord, two purusas as long, are fastened to the two pegs and the cord is stretched towards the east by holding its middle mark in hand Repeat the procedure at the eastern boundary of the wing This is the bending of the wing. Repeat the procedure for the other wing The detailed layout of the citi is not described since, it is the repetition of the same procedure of the Baudhāyana which is already described

In Baudhāyana Ś S the first type of falcon shaped 8 citi with curved wings is constructed with five types of bricks while, in Āpastamba Ś S the first type is constructed with 9 types of bricks [93]

1 The first type is a parallelogram of which length and breadth are 24 ang and 20 ang respectively, as in fig B_1

92 ĀŚS 15-1-17 16

93 ĀŚS 16-3-20

Indological Truths

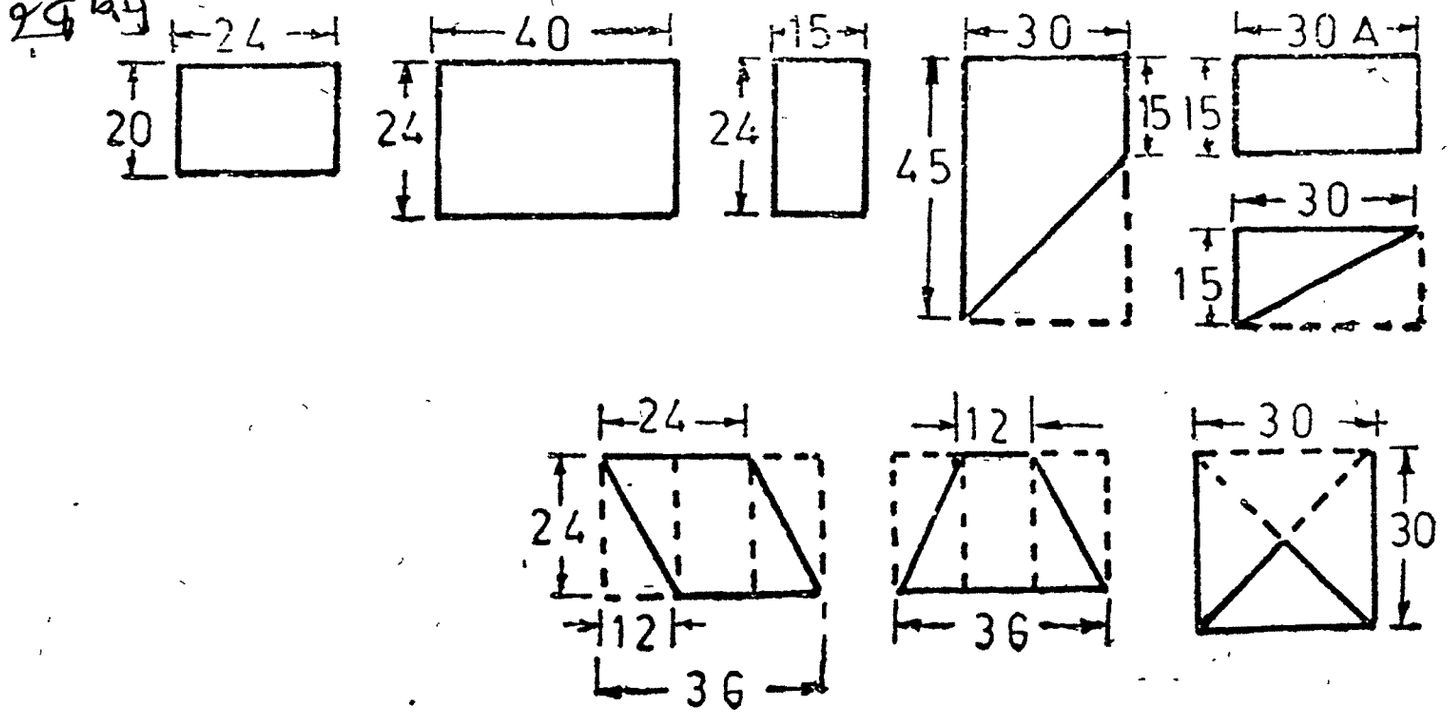


Fig. 56 Bricks for Śyena Citi

Indological Truths

2 The second type is obtained by joining the two of the above first type of bricks along the east line as in fig B_2

3 The third type is obtained by the one sixth purusa long of the first type and is extended by one eight of a purusa (15 ang), and (the extended part) is bent so as to fit (with the shape of the fire-altar) which is in the figure B_3

4 A square brick of side one-fourth of a purusa (30 ang) is lengthened by half, (the square portion of side one-fourth purusa diagonally cut off This is the fourth type as in figure B_4

5 The fifth type is a rectangle 30 ang by 15 ang (caturbhāgīyārdha) as in fig B^5

6 By dividing fifth type by the diagonal, the sixth type as in figure B_6

7 A rectangle of breadth one-tenth of a purusa (12 ang) and length one-fifth of a purusa (24 ang) in the direction from east to west is drawn one each such rectangle is placed on its southern and its northern side These two are cut off by diagonals passing through their south-west corners This is the seventh type as shown in the fig B_7

8 Likewise another type is formed in which the northern rectangle is cut off by the diagonal passing through the north (western) corner (the cutting off of the southern rectangle being as before) This is the eighth type in the fig B_8

9 The nineth type an isosceles triangle of base 30 ang and side 30 2 ang is obtained by dividing the square diagonally (Shapes of bricks are as shown in the figure - 56)

Arrangement of Bricks in the First layer [94]

Head Place at the junction of the head and the body two bricks of type IV above Keep two other bricks of this type in the head towards the east of these bricks

94 ĀŚS 16-2-10

Indological Truths

Body Place 26 bricks of type IV, eight bricks of B_6 and four bricks of type B_5

Wings Place 60 bricks of B_1 oriented towards the north, in each of the wings

Tail Place four bricks of B_6 at each of the two western corners of the tail Three of these are placed near the western border and one is placed behind them Place bricks B_4 at the junction of the body and the tail On their western side, place two bricks of B_5 Thus a layer of 200 is constructed

Arrangement of bricks in the second layer [95]

Head Two bricks of B_4 and four bricks of type B_9 are placed in the head

Body At the four corners of the body, place eight bricks of B_4 oriented towards the south and the north respectively In the remaining area of the body 20 bricks of B_4, 30 bricks of B_6 and one brick o B_5 are to be placed

The area of the body = $^1/_2$x180x60x2+180x120 = 10800+21600 = 32400 sq angulas

The area of 28 B_4 bricks = (30x15+$^1/_2$x30x30)x28 = 900x28 = 25200 sq angulas

The area of a B_5 brick = 30x15 = 450x30x15x30 = 225x30 = 6750 sq angulas Six angulas of bricks placed in the wings of the junction are inside the body The area occupied by these bricks = 6x120x2 = 1440 sq ang The total area of the bricks = 33840 sq angulas The area of the bricks as instructed by the Śulbasūtrakāra is in excess of the area of the body The arrangement of bricks according to Āpastamba may be as shown in the figure - 57

Tail At the two sides of the tail ten bricks of B_7 are to be placed Place 13 bricks of B_7 in the remaining area Actually 12 bricks of B_7 and B_{13} bricks of B_8 are placed

Wings In the centre of the wings five bricks of B_2 are placed None columns, each containing five bricks of B_1 are placed Five bricks of B_3 are placed at the junction of the wing and the body such that six angulas of the bricks will be inside the body

95 ĀŚS 17-6-16

Indological Truths

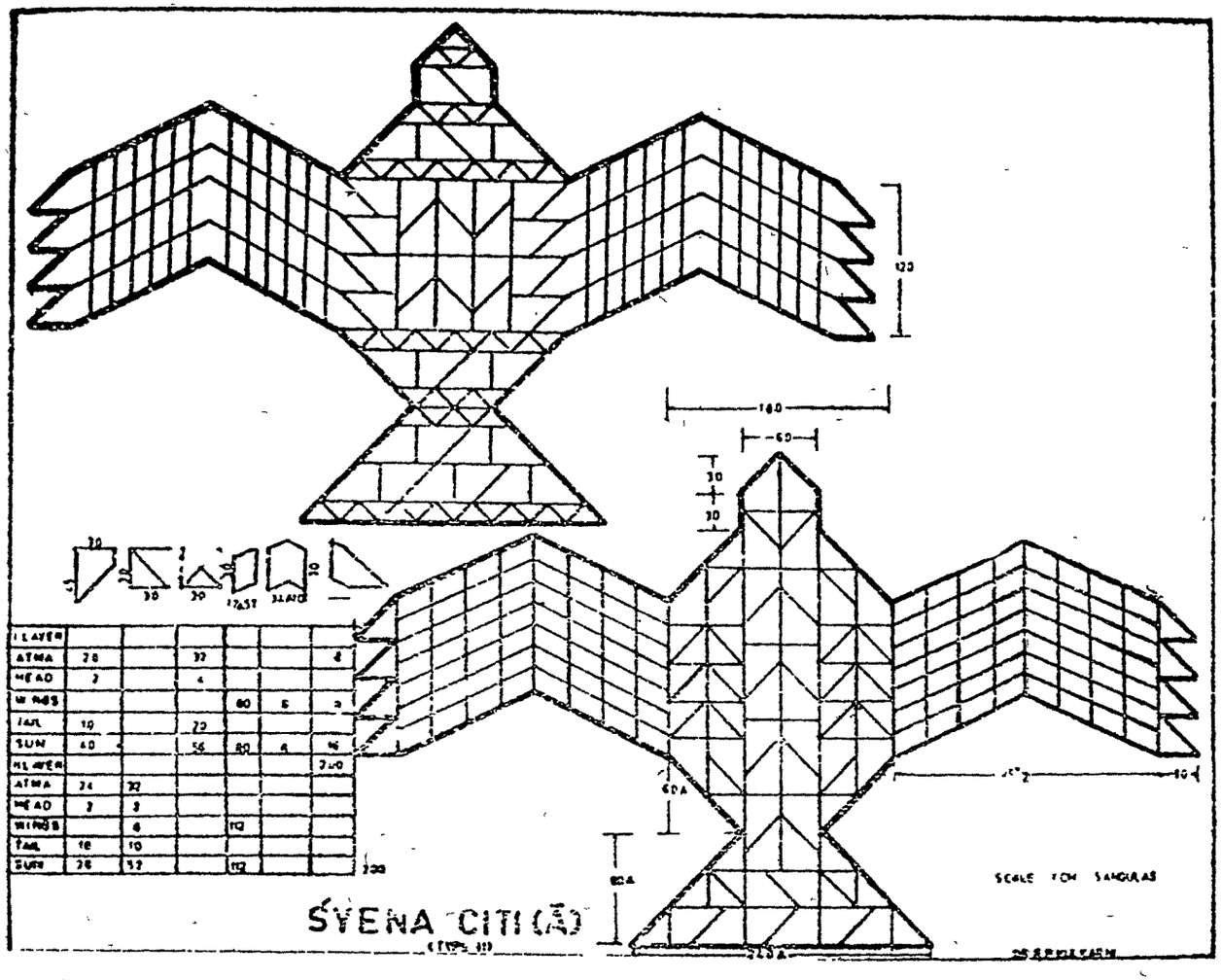


Fig. 13 Śyena Citi (Type II)

Indological Truths

The widthof the body occupied by the bricks is 45+15+15x3+45+15 = 165 angulas (180-165)x$^1/_2$=7$^1/_2$ angulas The bricks in the wings at the junction are inside the body of the citi by 7$^1/_2$ angulas The width of the wing is 228$^3/_4$ angulas The total width of the bricks in each wing is 20x9+40x1+15x1=235 angulas Thus 6$^1/_4$ angulas of bricks of 24x15 size are inside the body The difference of 7$^1/_2$-6$^1/_4$ angulas is small and it could be made up in by increasing the width of the joints along the width of the body (In fact, because of the bricks in the middle of wings are bent, their length is smaller than 40 angulas bricks of B_1 could be easily accommodated as shown in the figure - 58)

Arrangement of Bricks in two layers

Bricks	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
First Layer									
Head	–	–	–	2	–	–	–	–	–
Ātmā	–	–	–	36	10	–	–	–	4
Wings	120	–	–	–	–	–	–	–	–
Tail	–	–	–	10	2	16	–	–	–
Sum	120	–	–	48	12	16	–	–	4=200
Second Layer									
Head	–	–	–	2	–	–	–	–	4
Ātmā	–	–	–	28	9	22	–	–	–
Wings	90	10	10	–	–	–	–	–	–
alternately	100	10	–	–	–	–	–	–	–
Tail	–	–	–	–	–	–	12	13	–
Sum	90	10	10	30	9	22	12	13	4=200

Śyenaciti with curved wings and outspread tail (Type II)

Both Baudhāyana and Āpastamba describe the second type of a falcon shaped

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fire-altar with curved wings and extended tail Bodhāyana[96] explains this type of fire-altar in following way.

"In this case, the seven fold fire-altar with two aratni and one pradeśa is accomplished with $187\frac{1}{2}$ square aratni of the side equal to one-fifth of a purusa (pañcami) The body can accommodaet 52 of such pañcami bricks, the head $3\frac{1}{2}$, the tail 15, southern wing $58\frac{1}{2}$ and northern wing the same number of bricks as the southern "

The corners are cut off with $\frac{1}{2}$ vyāyāma (48 angulas) the tail is inclined, the bending of the two wings is done with 3 aratnis (72 angulas) each, the six plumages (at each end of the wings) are to be made with the half of bricks longer on one side by half of adhyardhā pañcami, the form of the head remains unchanged (i e the same as that of the falcon-shaped fire-altar described before)" [see figure - 59]

Layout of the Citi:

The body · The layout of the Śyenaciti is given by means of square bricks of sides of length equal to 24 angulas In the body of the Śyenaciti 52 bricks are to be placed It is not necessary to fabricate these bricks They only specify the area of different parts of the citi

From the Śyena citi of type I, it is known that the length of the body is 240 angulas and the width is 150 angulas Ten bricks of 24x24 angulas size fit in the length of 240 angulas, but a gap of six angulas remains along the width when six bricks are placed So let us take the width of the body as 144 angulas It is further clarified that the corners of this rectangle are to be subtracted by 48 angulas

The area of 52 bricks is 52x24x24=29952 sq ang

The area of the rectangle 240x144=34560 sq ang

The area of the corners, $\frac{1}{2}$x48x40x4=4608 sq ang

The area of the body of the citi, 34560-4608=29952 sq angulas

96 BŚS 4 44-74

Indological Truths

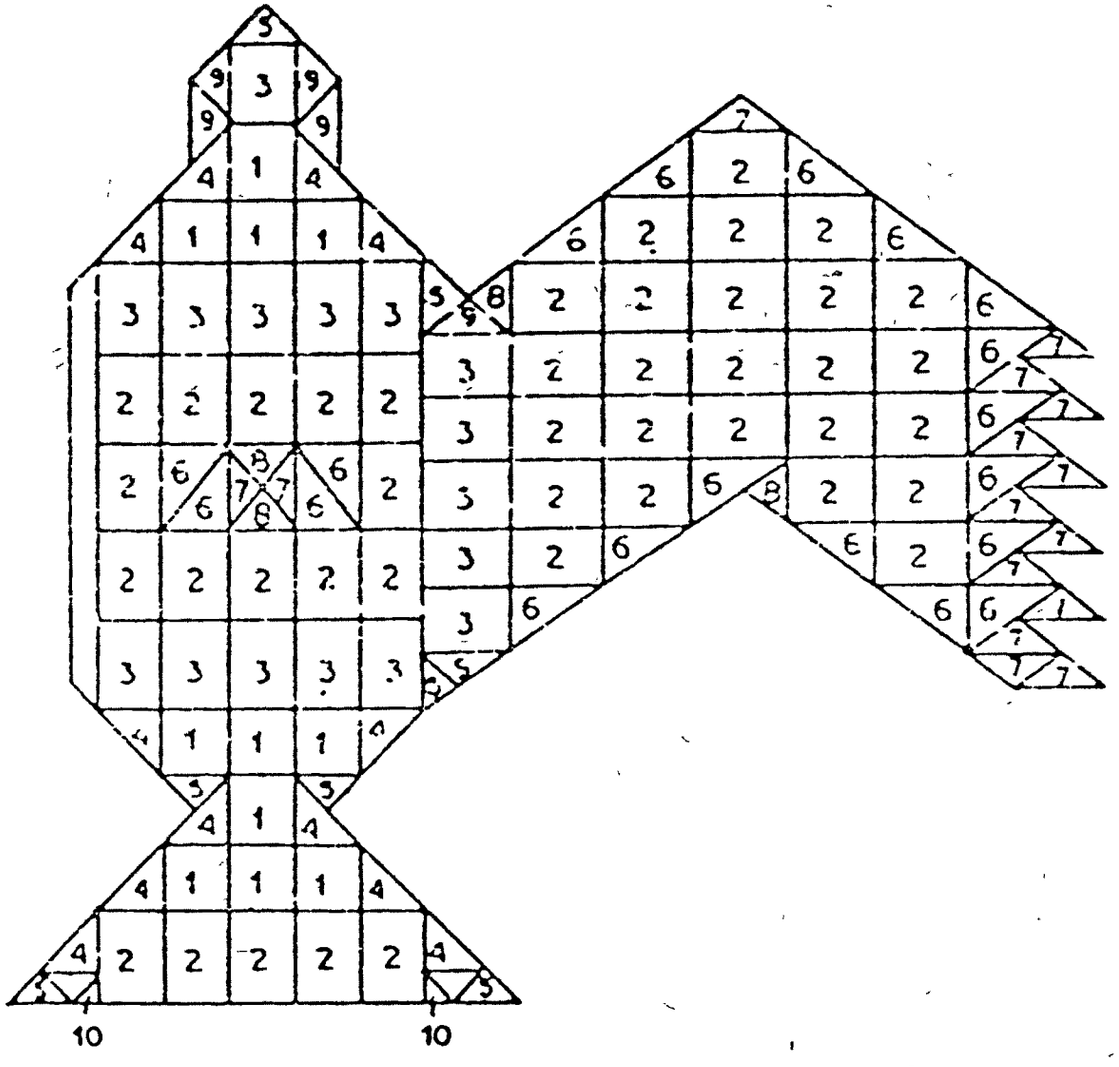

Fig. 44. Arrangement of bricks in the *śyenacit*—second type, second layer.

Indological Truths

The head . The area of the head is $3^1/_2$ bricks, which is 24x24x$3^1/_2$=2016 ang The dimensions of the head suggested are 48 ang. width and 54 ang length Corners, each of 24 ang sides are subtracted towards the east The area of the head is 48x24+$^1/_2$x48x24=1440+576=2016 sq ang It is found that for different sizes of the bricks suggested by the Śulbasūtrakāra for the construction of the śyena citi, these are the only suitable dimensions

The tail There are 15 bricks in the tail The area of the tail is 24x24x15=8640 sq ang The length of the eastern side of the tail is known It is 48 angulas The east west length of the tail is the multiple of 24 ang The length of the western side of the tail should be such that when two equal lengths are added into 48 angulas, the length of the eastern side of the tail, it should be divisible by 24 angulas The tail of the east-west length should be 72 angulas and length of the western side should be 192 angulas The area of this trapezium is $^1/_2$x72 (48+192)=8640 sq angulas

The wings The area of each wing should be equal to $58^1/_2$ sq bricks of sides of 24 aṅgulas which is equal to 33696 sq angulas

The wing before bending is of a rectangular shape the east-west side of which is 240-48x2=144 angulas Six feathers are formed by six adhyardhā bricks The area of six feathers is $^1/_2$x36x24x6=2592 sq ang This area is to be subtracted from the area of $58^1/_2$ bricks, i.e 33696-2592=31104 sq angulas The length, i e the north-south side of the rectangle is equal to 31104 divided by 144=216 angulas These are the dimensions of the wing. The bend of the wings is 72 angulas towards the east

Sizes of the bricks:[97]

Ten kinds of bricks have been prescribed for covering the fire-altar

B_1 - square brick of side $^1/_5$ pu pañcamī bricks 24x24 sq ang

B_2 - rectangular brick longer than pañcami by half, adhyardhā - pañcami 24x36 sq ang

97 BŚS 4-56-63

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B_3 - rectangular brick longer than 24x30 sq ang pañcami by a quarter, pañcami-sapāla

B_4 - triangular brick, half of one-fifth 24, 24, 24 2 ang pañcami-ardha

B_6 - triangular brick, half of adhyardhā, 36, 24, 12 3 ang , i e adhyardhāradhā

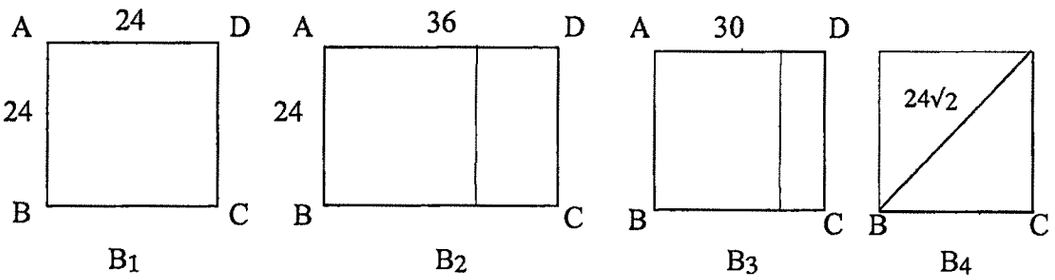
B_5 - triangular brick, quarter of 24, 12 2, 12 2 ang one-fifth pañcami-pādya

B_7 - triangular brick, quater of adhyardhā, with longer base BC=36 ang also called dīrghapādya

B_8 - triangular brick quarter of adhyardhā, with a short base BC=24 ang also called Śūlapādya

B_9 - triangular brick obtained by joining one one-eighth of pañcami brick as in the figure B_9

B_{10} - triangular brick one-eighth of pañcami 12, 12, 12 2 ang

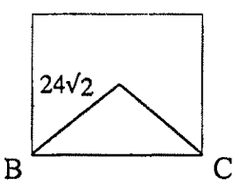


B_1

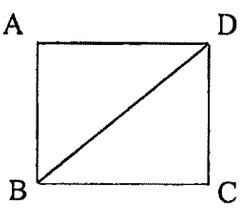
B_2

B_3

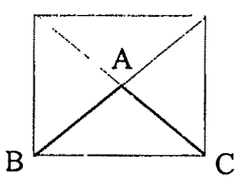
B_4



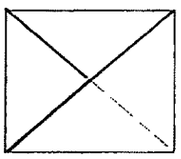
B_5



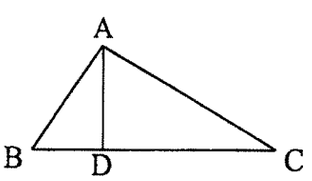
B_6



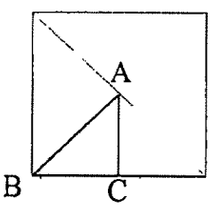
B_7



B_8



B_9



B_{10}

Indological Truths

Indological Truths

Arrangement of Bricks in the first layer [98]

In the ātman are to be placed pañcamis and half bricks In tail also pañcamis and ardhyā bricks are to be placed In both the wings adhyardhā bricks and their ardhās are to be placed In the head two ardhyā bricks are placed in front Two sapāda bricks are placed behind them

Second layer [99]

One ubhayī brick is to be placed on the eastern end of the two lines in which wings are joined with ātman Likewise one ubhayī brick is to be placed on the western end of the wing where the wing and ātman meet each other In both the wings adhyardhā bricks together with pādyās of adhyardhās are to be placed

Two ubhayī bricks are to be placed on each side of the head, i e four ubhayī bricks One sāpāda brick turned towards the east is to be located in the centre of the head One quarter brick is to be placed in the front portion of the head On the west side of the tail, adhyardhā bricks are to be placed, turned towards the east on both the sides of the five adhyardhās are to be placed pādyās and bricks equal to the eighth part of a pañcamī

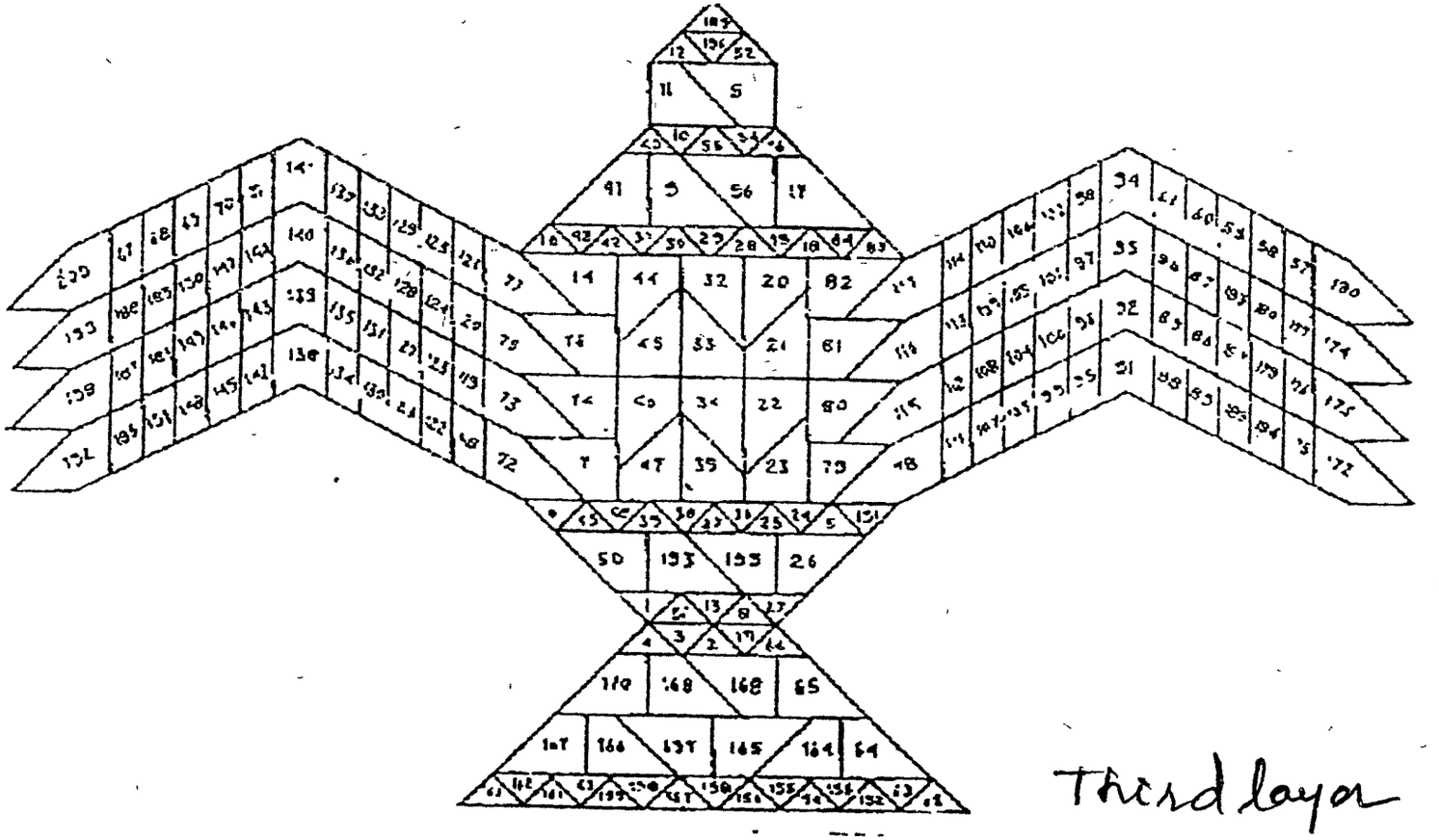
Arrangement of bricks in the body is to be made as given in the figure The number of bricks can be classified as follows

Bricks	Pañcamā 24x24A	Ardhya-rdhā 30x24A	Sapādā 30x24A	Ardhyā	Pādā	Ārdhyā of Abhya-rdhā	Dīrgha -oāda	Śula-pāda	Ubhayi	Aṣṭamī
First Layer										
Ātmā	44	–	–	16	–	–	–	–	–	–
Wings	–	40	–	–	–	76	–	–	–	–
Head	–	–	2	2	–	–	–	–	–	–
Tail	10	–	–	10	–	–	–	–	–	–

98 BŚS 4-64-67

99 Ibid 4 68-74

Indological Truths



Third layer

Sum	54	40	2	28	–	76	–	–	–	=200
Second Layer										
Ātmā	7	–	20	6	4	8	2	2	4	–
Wings	–	50	10	–	–	30	26	4	–	–
Head	–	2	–	–	1	–	–	–	4	–
Tail	4	5	–	6	4	–	–	–	–	2
Sum	11	56	30	12	9	38	28	6	8	2=200

According to Āpastamba Śulbasūtra,[100] the II type of Śyenaciti is constructed in the following way

Layout of the citi:

A square brick of $^1/_{16}$th area of one sq purusa area ($^1/_{16}$x120x120) is of the sides 30 angulas long 120 such bricks make an area of $7^1/_2$ sq purusas which is equal to 108000 sq angulas Place 40 bricks in the body, three in the head, 31 in each of the wings and 15 in the tail Total number of bricks is 120

Body Draw a rectangle of 240 angulas east-west length and 180 angulas width Remove two bricks from each corner In the rectangle of 240x180 angulas, 48 bricks of 30x30 angulas can be accommodated (30x8=240 and 30x6=180) Two bricks from each of four corners are removed The area of the body is therefore, equal to 40 bricks=3600 sq angulas.

Head Draw a square of one-half purusa length 60x60 angulas Four bricks of 30x30 angulas are accomodated in it After removing one-half brick from each of the two eastern corners, there remain in all three bricks The area of the head is thus 900x3=2700 sq angulas

Wings Draw a rectangle of $247^1/_2$ angulas north-south length and 120 angulas width The length of the wing is $217^1/_2$ angulas, the length of the four feathers being 30 angulas Place four bricks of 30x30 angulas size at the locations of the feathers and remove one-half brick along the diagonal of each brick Two bricks are

100 ĀŚS 18 1-20-19

Indological Truths

Fourth layer ⑤

Indological Truths

accommodated as feathers The total area of the rectangle is $247^{1}/_{2}$x120=29700 sq ang which accommodates 33 bricks After removing the two bricks there remain, in one wing, 31 bricks the area of which is 31x900x2=27900 sq angulas The area of the two wings is thus 55800 sq angulas

Tail The length of the western side is two purusas (240 angulas) the length of the eastern side is one-half purusa (60 angulas) 18 bricks of 30x30 angulas could be placed One half bricks from both the sides are removed The number of bricks remained are 15 The area of the tail is 15x900=13500 sq angulas

Arrangement of bricks in the First layer [101]

Head Place four pādyā bricks in the front part of the head Place two 'sodaśi' bricks behind them Body and Tail - Near the junction of the head and the body place- five pādyā bricks Near the eastern and the western sides of the body, just beyond the junction of the body and the wings, 11 pādyā bricks are placed in the tail near its eastern border, i e on the two sides of the junction of the body and the tail 15 pādyā bricks are placed at the western border of the tail The remaining area is filled with soḍaśi bricks The hypotenuse of the sodaśi bricks are aligned along the diagonal sides of the body

Wings Four paksagriyā bricks are placed at the southern border of the south wing so as to look like feathers Four such bricks are placed at the junction of the body and the wings

Arrangement of bricks in the second layer [102]

Head Place two sodaśi bricks with their hypotenuse along the diagonal border of the head

Body Behind the sodaśi bricks, place two sodaśi bricks with their hypotenuse inside the body Fill the space in between with two ardhyā bricks Sodaśi bricks are used with their hypotenuse aligned along the diagonal sides of the body The remaining area is to be constructed by using sodaśi and ardhyā bricks

101 ĀŚS 19 14-18, 20 1-6

102 ĀŚS 20 7-18

Indological Truths

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Wings Place four ardhyā bricks at the south end of the south wing so as to appear like feathers The remaining area is filled by paksistikā oriented towards the north

Tail Place three ardhyā bricks, each set near the south and the north borders The remaining area is to be filled with soḍaśi bricks

Different types of bricks:

But Mānava Śulbasūtra[103] has given only one type of Śyena citi with curved wings it is as follows

Layout of the Citi

One part of the citi is equal to 30x30=900 sq ang area The area-wise divisions of different parts of the Śyena citi are as given below

The body of the citi is of 26 parts = 26x30x30=23400 sq ang

Each wing of the citi is of $37^1/_2$ parts=$37^1/_2$x30x30=33750 sq ang

The head of the citi is of 4 parts=4x30x30=3600 sq ang

The tail of the citi is of 15 parts=15x30x30=13500 sq ang

Head Draw a rectangle of the width of 60 angulas and the east-west length of 75 angulas The south-east and the north-east corners of the sides of 30 angulas are subtracted These are the shape and the dimensions of the head of the citi Its area is 60x45+$^1/_2$x60x30=3600 sq angulas

Body Draw a rectangle of the width of 120 angulas and the east-west length of 210 angulas Cut four corners of 30 angulas length The area of the body is $^1/_2$ (60+120)x30+120x150x$^1/_2$ (60+120)x30=2700+18000+2700=23400 sq angulas

Wings The wings have five feathers, unlike six as prescribed by Baudhāyana These feathers are formed by five aksnā bricks of the size 30x30x$42^1/_2$=2250 sq ang This area is subtracted from the area of the wings, 337510-2250=31500 sq ang The width of the wing, 150 angulas being its north-south length is therefore,

103 MŚS 10 3 5 11, 3-26

Indological Truths

31500II150=210 angulas Draw a rectangle of 210x150 angulas The bending of the rectangle is 105 angulas

Tail The eastern width of the tail is 60 angulas, the length of the west side is 240 angulas and the east-west distance between these two sides is 90 angulas The area of this trapezium is $^1/_2$ (60+120)x90=135000 sq angulas

Sizes of Bricks [104]

There are four kinds of bricks Square-shaped bricks of 40x40 ang called navabhāgā Triangular bricks of 30x30x42$^1/_2$ ang are called aksnā bricks Triangular bricks 21$^1/_4$x21$^1/_4$x30 ang (i e $^1/_4$th in the area of a brick of $^1/_4$th purusa length) called ardhākṣnā and pañcakonā (five cornered brick) of 21$^1/_4$x21$^1/_4$x15/30/15 ang sides

Arrangement of Bricks in the First layer:[105]

On the eastern side of the head, place two pañcakonā bricks along with two ardhāksnā bricks at the bend of each of the wings Place navabhāgā bricks in the centre of the body and aksnā bricks near the corners of the body The feathers the end of each wing are constructed by providing five aksnā bricks opposite each other and also provide pañcakonā bricks with heads in oppposite directions Place two ardhāksnā bricks at the borders of the body and the wings and also at the border of the tail and the body Place 15 ardhāksnā bricks at the western border of the tail and 21 bricks of the same type at the eastern part of the wings near their bends

Arrangement of second layer is not given in Mānava Śulbasūtra

Bricks	**Navabhāgā 40x40A**	**Akṣṇā 30x30A x42^1/2A**	**Ardhākṣṇā 21^3/4x21^1/4 x30A**	**Pañcakoṇā**	**Pādākṣṇā 15x15**
First Layer					
Head	–	4	2	2	–
Ātmā	9	8	8	4	8
Wings	–	124	44	2	4

104 MŚS 10 3 5 21

105 Ibid 10 3 5 22-25

Indological Truths

Tail	–	24	12	–	–
Sum	9	160	66	8	12 =255

Thus the total number of bricks in first layer is not 200 but 255

Comparison of the areas according to Baudhāyana and Āpastamba of two types of Śyena citi may be tabulated as follows

First type

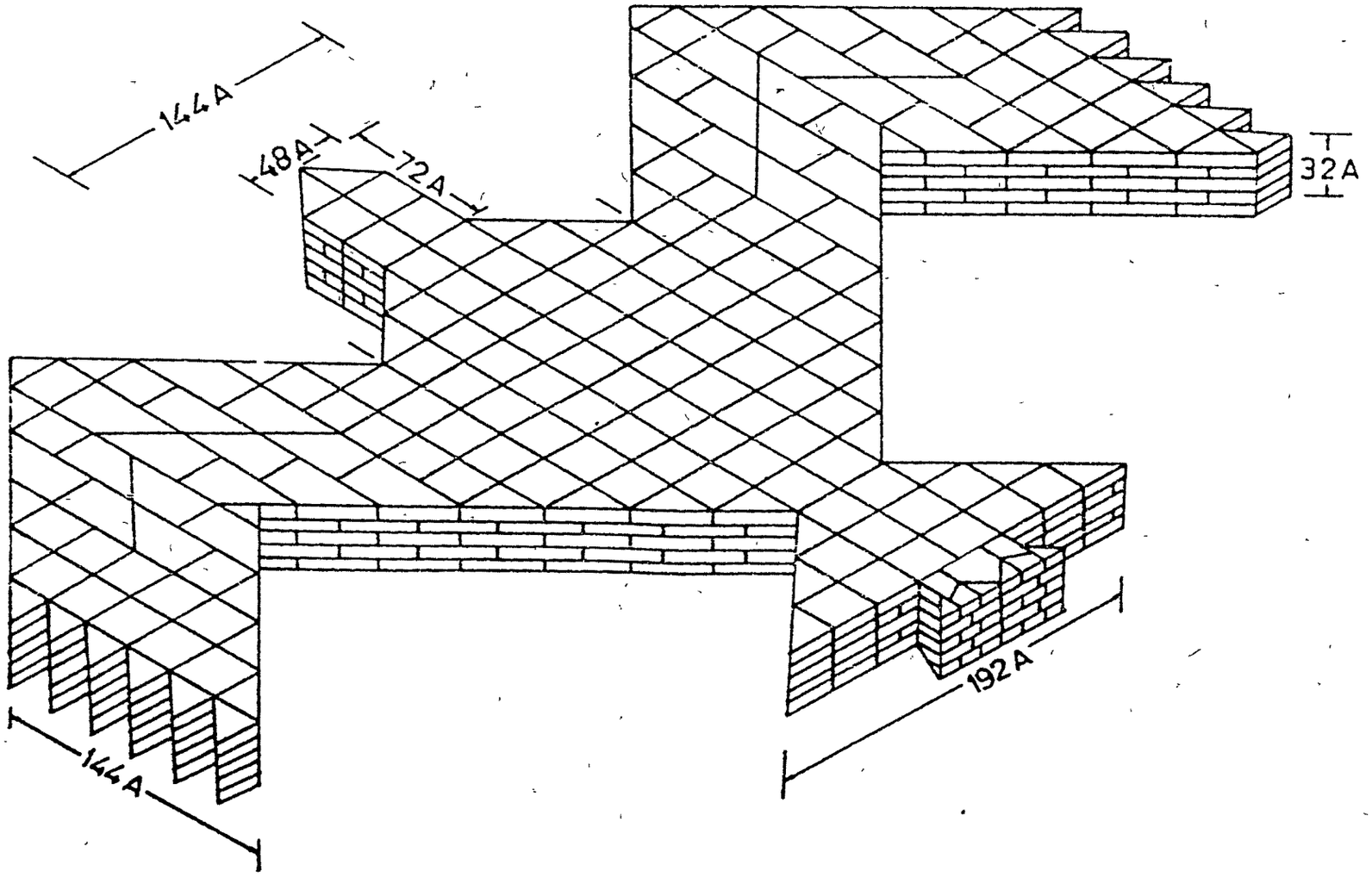
Baudhāyana	Āpastamba
Area of the head=4050 sq ang	Area of the head=2700 sq ang
Area of the body=31950 sq ang	Area of the body=36000 sq ang
Area of the wings=58400 sq ang	Area of the wings=2(27450) sq ang /54900
Area of the tail=13500 sq ang	Area of the tail=144000 sq ang
Total area=10800 sq ang=$7^1/_2$ puruṣa	Total area = 108000 sq ang =71/2 sq purusas

Second type

Baudhāyana	Āpastamba
Area of the body=29952 sq ang	Area of the body=36000 sq ang
Area of the head=2016 sq aṅg.	Area of the head=2700 sq aṅg
Area of the wings=67392 sq ang	Area of the wings=2(27900)/55800 sq ang
Area of the tail=8640 sq ang	Area of the tail=13500 sq ang
Total area=10800 sq ang	Total area=108000 sq ang

Mānava
Area of the body=23400 sq ang
Area of the head=3600 sq ang
Area of the wing=2(33750)/67500 sq ang
Area of the tail=13500 sq ang
Total area=10800 sq ang

Indological Truths



KANKA CITI

Indological Truths

Kaṅkacit : (Construction of a fire-altar in the form of a Kite):[106]

The kite-shaped fire-altar is constructed in the same manner as the Śyenacit The areas and shapes of the body and the tail are the same as those of the second type of the falcon with curved wings and extended tail The area of the body is, therefore, 52 pañcamis or sq aratnis and of the tail 15 pañcamis The measure of head is given as 5 pañcamis and that of two wings 2x57 or 114 pañcamis These areas total 186 pañcamis leaving a deficit of $1^1/_2$ pañcamis as thetotal area of the fire-altar is $187^1/_2$ pañcamis (=$7^1/_2$ sq pu) This balance area of $^1/_2$ pañcamis, which is nothing but 1 adhyardhā pañcami (24x36 sq ang) is of the wing and plumages are also slightly different from those of the Śyenacit, 2nd type The construction as per Baudhāyana is shown in the figure - 60

Layout of the citi [107]

The Body and the tail The dimensions of the body and tail of the Kanka citi are same as those of the "Śyenaciti, type II" of Baudhāyana

The Head There should be five pañcamī bricks (24x24 angulas)-size in the head the area of the head is 2880 sq angulas The width of the head is 48 angulas The length of the head is 72 angulas and corners ofthe sides of 24 angulas are subtracted towards the east from the rectangle As the sizes of the bricks are in the multiple of 24 angulas, this is the right length of the corners the area of which is to be subtracted from the rectangle of 48x72 angulas The area of the head is 72x48-$^1/_2$x24x24x2=3456-576=2880 sq angulas

The Wings 57 bricks are to be placed in each of the wings The area of the wing is 57x24x24=328328 sq angulas The width of the rectangle is 144 angulas which is equal to the southern side of the body Six numbers of ardhyā of pañcamī bricks are to be placed as feathers The area of feathers is $^1/_2$x24x24x6=1728 sq ang The area of the rectangle forming the wing is 32832-1728=31104 sq angulas The

106 BŚS 4-75-91

107 BŚS 75-85

Indological Truths

length of this rectangle is 31104II144=216 angulas The bending of the wing is by 108 angulas

The Feet The total number of the bricks of the size 24x24 angulas is $187^{1}/_{2}$ Their total area is 108000 sq ang

Bricks used in the body=52=29952 sq ang

Bricks used in the tail=15=8640 sq ang

Bricks used in the head=5=2880 sq ang

Total number of bricks used=186=107136 sq ang

The remaining number of bricks is $1^{1}/_{2}$ of the area equal to 864 sq angulas The feet are of the area equal to 864 sq angulas

Placement of bricks in the first layer [108]

The rule of Baudhāyana simply lays down that the two feet of the Kankacit are to be covered by B_5 and B_4 bricks and the remaining space is to be filled up by such types as these fit Further details have been avoided as enough indications as to the manner of covering up such bird-like fire-altars with curved wings and extended tail have been given in the foregoing types Arrangement of bricks in the kankacit, the body, head and tail are constructed by using pañcami 1 bricks (24x24 angulas) wherever there is a diagonal line, triangular ardhyā bricks with their hypotenuse along diagonal lines are used

Types of bricks Six types of bricks are prescribed for covering the fire-altars

B_1 - square brick of side $^{1}/_{5}$ pu pañcami

B_2 - triangular brick, half of one fifth, pañcami-ardhyā

B_3 - triangular brick, quarter of one-fifth, pañcami-padyā

B_4 - triangular brick, one-eighth of one-fifth, astami

B_5 - four-sided quarter brick of area $^{1}/_{4}$ pañcami, caturasra-padyā The sides are 6 ang , 12 ang , 18 ang and 122 ang Its area is 144 sq ang

108 BŚS 4 86 91

Indological Truths

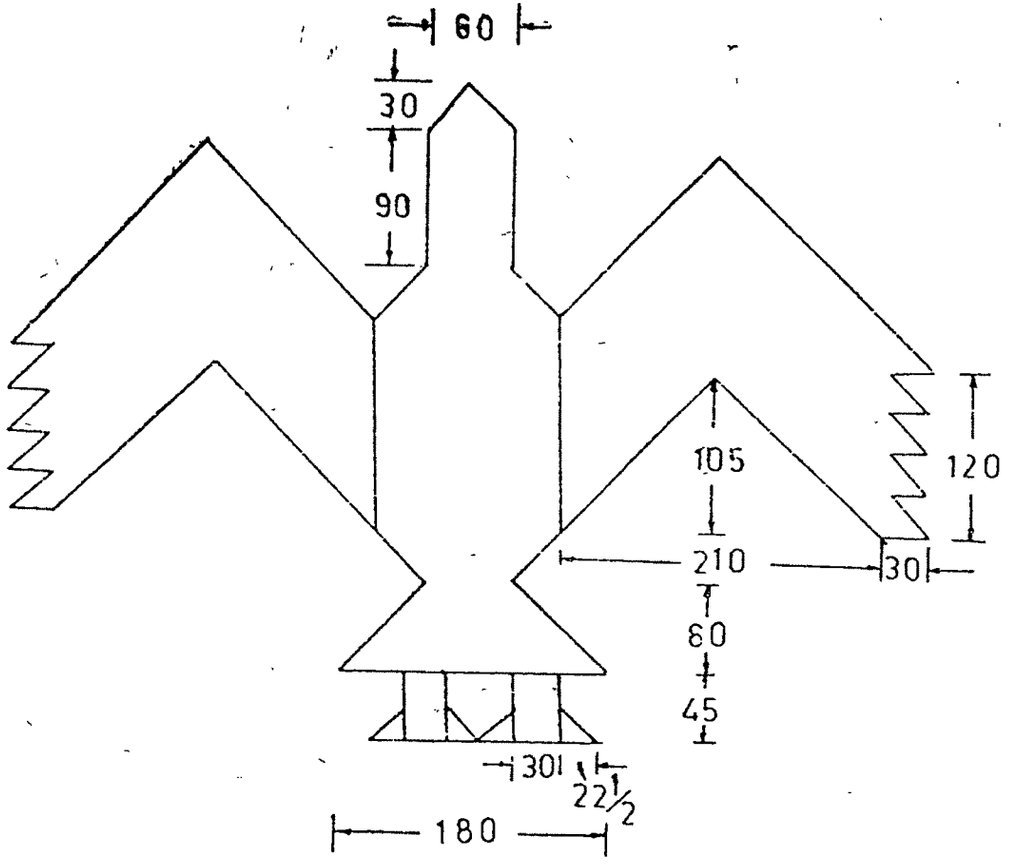


Fig 6 Dimensions of Kanka City

Indological Truths

B_6 - four-sided brick of area $1\frac{1}{2}$ pañcami, caturasra-ardha The sides are 24 ang , 24 ang , 48 ang and 24 2 The area is (24x24+12x24 sq ang or $1\frac{1}{2}$ pañcami

All these bricks may be shown in figure

Arrangement of bricks in the second layer

Here the arrangement of bricks is similar to the one given in the first layer, with some slight difference, so that the joints of the lower layer For this purpose a pāda brick is kept at the eastern most end of the head and again pāda bricks are kept at the westernmost end of tail The joints of bricks in the north-south directions are thus at different locations than those of the first layer Further, in case of the first layer there is an east-west joint along the centre of the citi In the second layer, the middle of bricks are located along this joint of the first layer In the first layer, there is a joint at the junction of the wings and the body and there is no joint at the middle of the wings, whereas there is no joint at the junction between the wings and the body and there is an east-west joint at the middle of the wings in the second layer At the same time, the symmetry of the arrangement of bricks is achieved

Bricks	Pañcamī	Ardhyā	Pāda	Aṣṭamī	Four cornered Adhyardhā	Pada
First Layer						
Ātmā	48	8	–	–	–	–
Wings	42	28	4	–	38	–
Head	4	2	–	–	–	–
Tail	12	6	–	–	–	–
Feet	–	–	4	–	–	4
Sum	106	44	8	–	38	4 =200
Second Layer						
Ātmā	36	8	2	–	4	–
Wings	–	12	24	–	72	–

Indological Truths

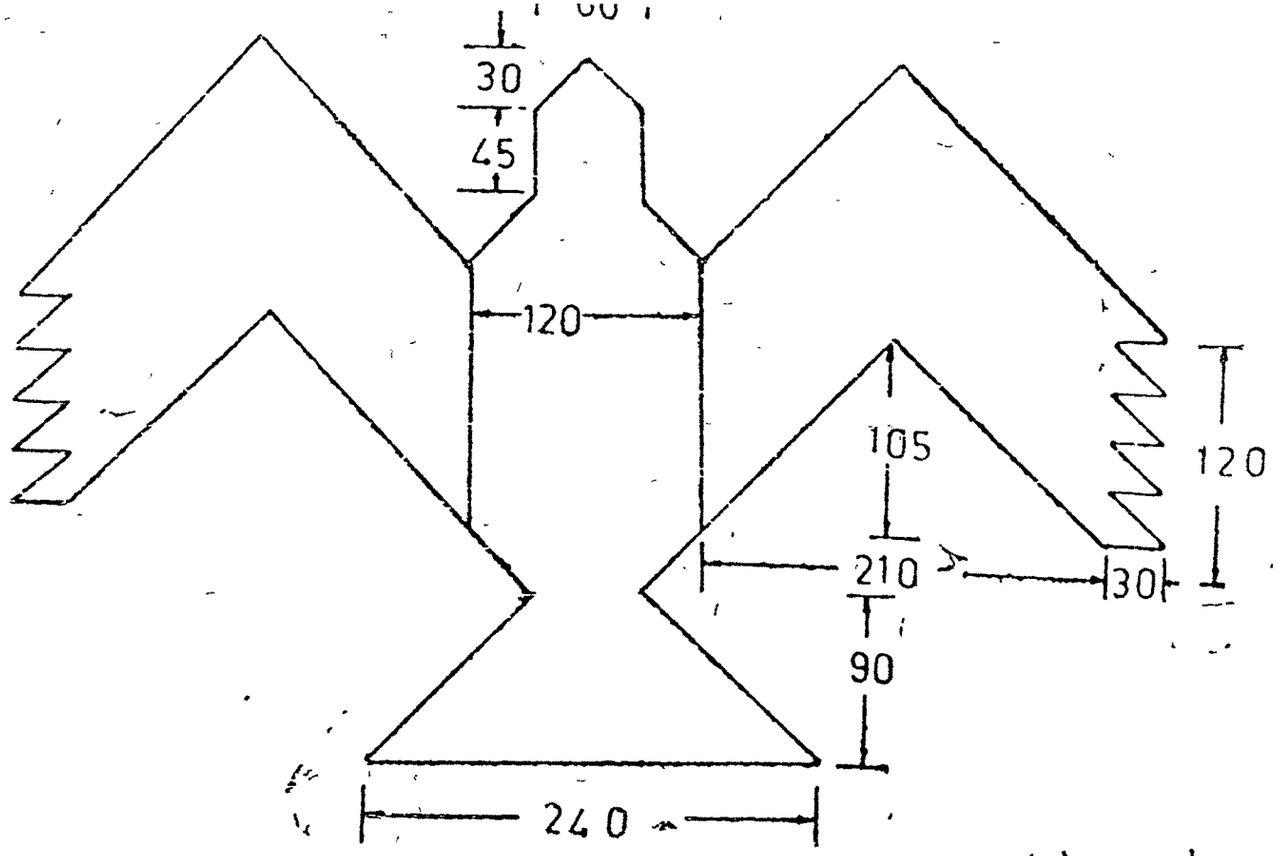


Fig.6 Dimensions of Śyena Citi — Alaju bird

b2

Indological Truths

Head	–	–	9	–	2	–
Tail	–	4	13	–	6	–
Feet	–	–	–	4	–	4
Sum	36	24	48	4	84	4 =200

The Āpastamba[109] and Mānava[110] followed the same method in the construction of kanka citi and that I explained briefly after the explanation of the construction of Alaja bird

Construction of a fire-altar in the form of an Alaja bird:[111]

The construction of this type of fire altar is explained in the same manner as those of the 'Kankacit' with the two feet with drawn 63 pañcami bricks are to be accommodated in the southern wing and the same in the northern The bending of two wings is done with 4 purusa (120 angulas) towards east from the western bend, a cord is stretched along the line of intersection of the westernmost plumage and the part lying west of the cord cut off In this way an area equivalent to $5^1/_2$ pañcami bricks stands removed 1 quarter brick is placed at each western bend to fill up the triangular void caused by the aforesaid removal Out of the brick types the four-sided quarter bricks and the one-eighths are to be taken away, and the remaining space of the fire-altar is to be filled with remaining types of bricks such that fit the required number of 200 bricks in the layer is attained (See the figure - 61)

In each wing the arrangement is as follows

a) At the layer along the bending (nirnāma) east-west

B_1=4, B_3=1, B_6-1 Ī Total - 6

b) In the 4 layer north of the nirnāma, there are

4 B_6s in each layer Ī Total - 16

c) In the junction layer between wing and body

B_3-1, B_6=4 Ī Total - 5

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109. ĀŚS 21 1-3

110 MŚS 10 3 5 2-6

111 BŚS 4 92-99

Indological Truths

d) In the 4 layers south of the nirnāma each contains 2 B_1s in the middle, 1 B_6 each at least and west end- B_1=8, B_6-8 Ī Total - 16

e) In the plumage (patras) as in Kankacit B_2-5, B_3-10 Ī Total - 15

The total for the southern wing, including the junction layer - 58

The total for the northern wing including the junction layer - 58

Kanka[112] and Alaja[113] citis according to Mānavă Śulbasūtra

Āpastamba and Kātyāyana mentioned with a statement that they are also described when Śyena citi is described But Mānava not only mentioned these two citis, but also, given the layout of the citis

Layout of the Kaṅka citi:

The body and the wings are similar to those of the Śyena citi

The area of the head is 7 parts=7x30x30=6300 sq ang

The area of the body is 26 parts=26x30x30=23400 sq ang

The area of the wing is $36^1/_2$ parts=$37^1/_2$x30x30=33750 sq ang

The area of the tail is 8 parts=8x30x30=72000 sq ang

The area of the feet is 4 parts=4x30x30=36000 sq ang

The total area = 108000 sq angulas

Head Draw a rectangle of 60 angulas width and 120 angulas length Subtract corners towards the east by 30 angulas The area of the head is 60x120-$^1/_2$x2x30x30 =7200-90=6300 sq ang

Tail Draw a trapezium of which the eastern side is 60 angulas long, the western side in 180 angulas and the distance between the east and west lines is 60 angulas

The area of the tail is $^1/_2$ (60+180)x60=7200 sq ang

The area of the feet=30x45x2+4+$^1/_2$x22$^1/_2$x22$^1/_2$=3600 sq angulas

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112 MŚS 10-3 5-2-6

113 Ibid 10 3 5-1-6

Indological Truths

The arrangement of bricks is not given in Mānava Śulbasūtra

Alaja Citi

Layout of the citi

The body and the wings of the citi are identical to those of the Śyena citi already described

The area of the head is 2 parts=2x30x30=1800 sq ang

The area of the body is 26 parts=23400 sq ang

The area of the wing is $37^1/_2$ parts=33750 sq angulas

The area of the tail is 17 parts=15300 sq angulas

Head Draw a rectangle of 60 angulas width and 45 angulas east-west length Subtract the corners, towards the east, which are 30 angulas in length The area of the head=60x15+$^1/_2$x60x30=1800 sq angulas

Tail Draw an isosceles triangle with the base 240 angulas long and of 120 angulas (east-west) height Place another triangle towards the east, with its apex in contact with the apex of the above triangle The north-south base of the triangle is 60 angulas long and in height is 30 angulas

The area of the tail=$^1/_2$x240x120+$^1/_2$x60x30=14400+900=15300 sq ang

Wings The bend of the wings is not sharp but its western side is flat by a length of $21^1/_4$ angulas The eastern side of the wings is with a sharp corner

The arrangement of bricks is not given in the Mānava Śulbasūtra

Mānava Śulbasūtra[114] given the construction of the Śyena, Alaja and Kanka fire-altars

In the Śyena fire-altar there are $37^1/_2$ parts in the left wing, 4 in the head 26 in the body, and 15 in the tail The alajacit has 17 parts in the tail, 2 in the head, and the same number of parts in the body and the (two) wings (as in Śyena) These are measured by bricks of side one-fourth of a purusa intermingling the joints of the parts

114 MŚS 10 3 5-2-6

Indological Truths

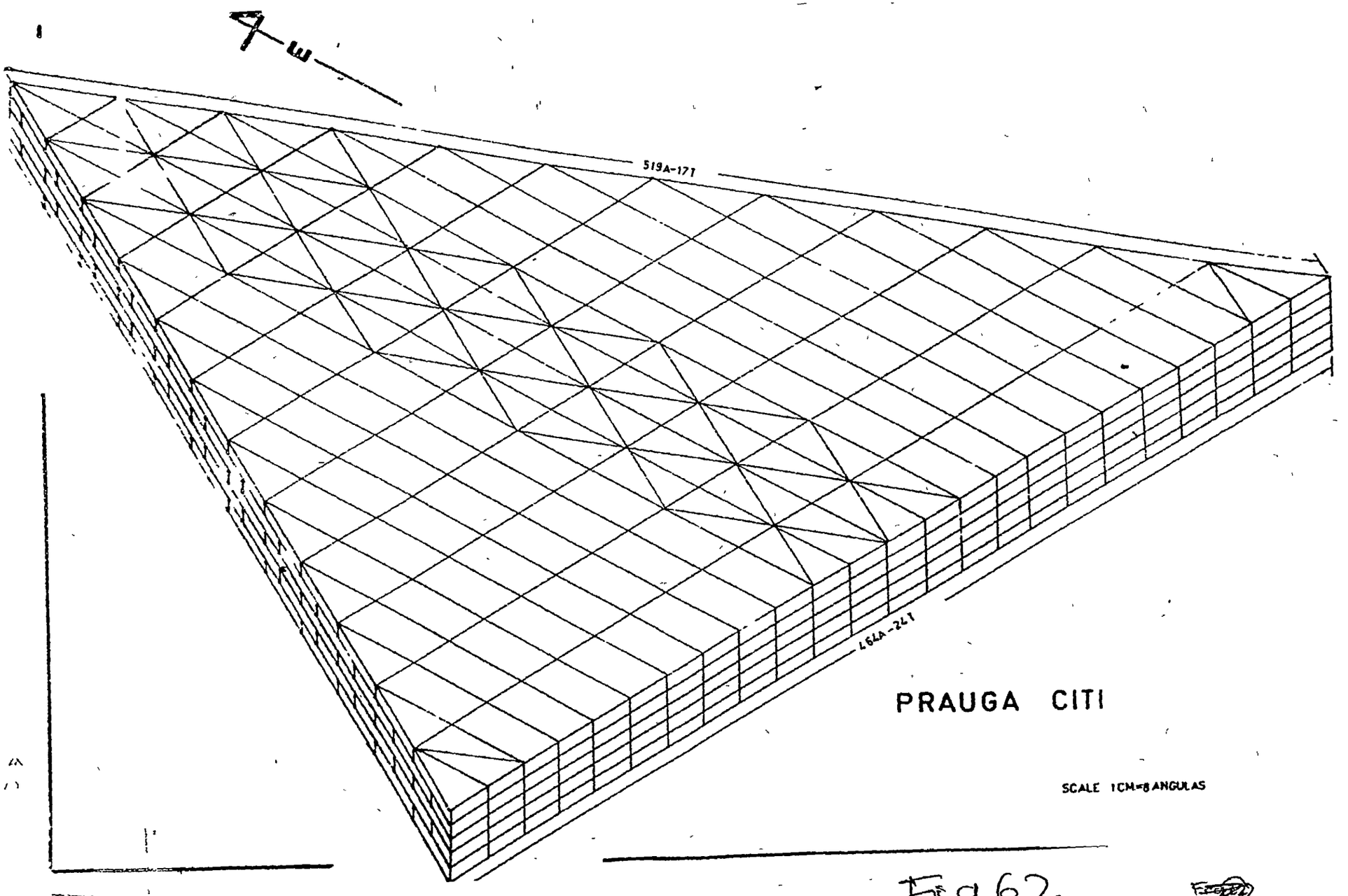

Fig 62

Indological Truths

In the Kankacıtı, 8 parts are ın the taıl, 4 parts ın the feet and 7 parts ın the head, the body and the two wings have the same number of parts as ın the Śyena In the construction of Śyena, Alaja and Kanka fire-altar, $8^1/_2$ parts are spread out ın the taıl, 4 parts ın the body, 2 parts ın the head and 5 parts ın each of the wings In the Śyena, Alaja and Kaṅka fire-altars two cornered, three cornered and four cornered brıcks are used ın the taıl The five (brıcks used) at the ends of the wings are those obtaıned by cuttıng the (orıgınal brıcks) by the dıagonál Two parts are added to the taıl ın the alaja whıch ıs fılled up by three cornered brıcks, three parts are transferred from the taıl of the Śyena to the head of the Kanka, and two parts are agaın cut off for each foot of the Kanka $12^1/_2$ parts are measured along east, 20 ın north, 15 parts for Kanka and $13^1/_2$ for alaja ın the north The areas of dıfferent parts of Śyena, Alaja and Kanka fire-altar may be shown ın the table - see the figure 61)

Construction of a fire-altar ın the form of an ısosceles trıangle (Praugacıt)[115]

Name ıtself ındıcates that thıs Praugacıtı ıs ın the form of an ısosceles trıangle equal ın area to the seven fold fire-altar wıth two aratnıs and one pradeśa (ı e $7^1/_2$ sq purusa) ıs laıd Brıcks of length equal to one-twelfth of ıts western sıde and breadth equal to half of the length are to be made, then brıcks whıch are half and quarter (of the brhatıs) Of them two half brıcks wıth theır hypotenuses turned outwards are to be placed ın the apex and half brıcks on both sıdes The rest of the fire-altar ıs to be covered wıth brhatı and the number of 200 brıcks ıs to be completed wıth half brıcks In the other layer 47 quarter brıcks mutually joıned wıth one another are to be placed on the western sıde of the trıangle 1 śulapādyā short based quarter brıck ın the apex ıs to be placed 4 quarter brıcks- 2 wıde-based (dīrghapādya) and 2 of the other type are to be placed ın the space of the svayamātrnna and half brıcks on the two sıdes The rest of the fire-altar ıs to be covered wıth brhatı brıcks (wıth length) turned towards east, and the number ıs to be completed wıth half brıcks The placement of brıcks ın both 1st layer and 2nd layer are shown ın the fıgure - 62

The followıng four types of brıcks are prescrıbed

115 BŚS 4-100-110

Indological Truths

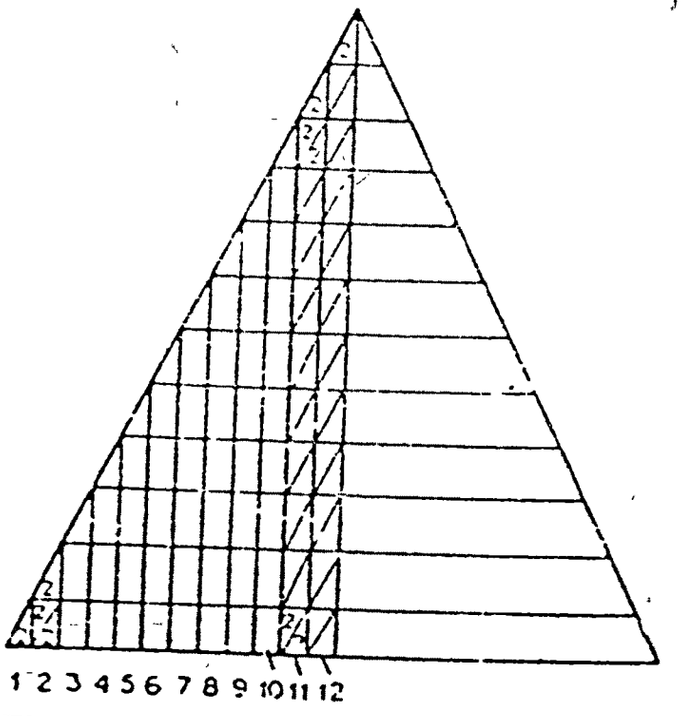

Fig. 54. Arrangement of bricks in the *praugaciti*—1st layer.

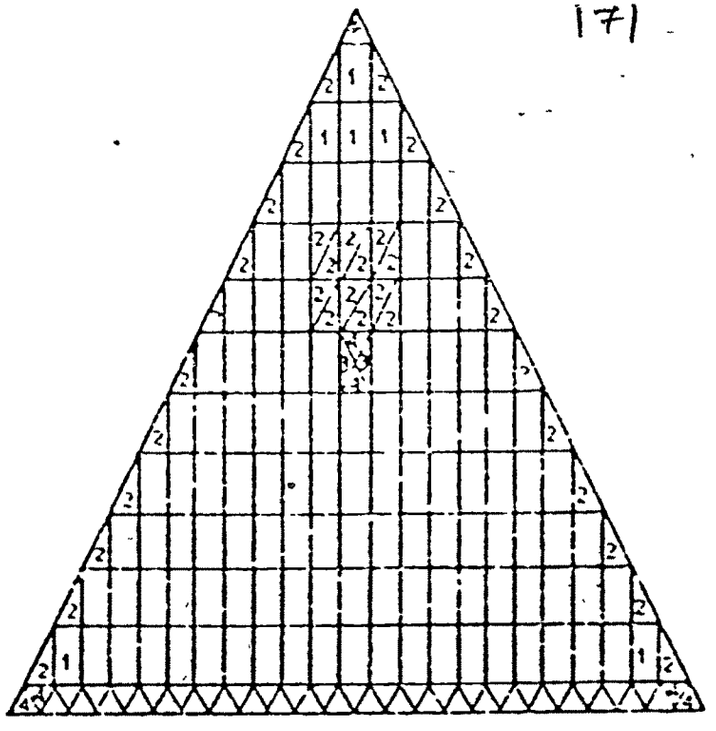

Fig. 55. Arrangement of bricks in the *praugaciti*—2nd layer.

Indological Truths

B_1 - a rectangular brick brhatī, 1015x5 15

B_2 - a triangular quarter brick half of the brhati diagonally intersected

B_3 - a triangular quarter brick with long base, dīrghapādyā

B_4 - a triangular quarter brick with short-base and pointed like a spear, Śulpādyā

Constructional method:

Hammer down two pegs along prācī (the east-west centre line) of the citi at a distance of 464 angulas, 24 tilas Fasten the ends of the cord to the pegs and pull it towards the south by holding it at the dividing mark Drive a peg where the mark at 232 ang -12 tila length is located on the ground Repeat the procedure towards the north side Then reverse the positions of the knots so that the knot fastened previously at peg B is fastened to peg B and the cord is again stretched towards south holding the dividing mark in the hand. Then drive a peg at mark a distance of 232 ang -12 tila Repeat the procedure towards the north Thus a square of the required dimensions is obtained [116] Fasten a cord from peg A located at the middle of the east side of the square to the peg at the south-west corner and a third cord joins the pegs at the south-east corners A triangle, a Prauga, of the desired area of 71/2 sq purusa is obtained

Layout of Citi according to Mānava [117]

Draw a square of the area equal to 15 sq purusas Measure a distance of ten aratnis from the north-east corner This is the mid-point of the eastern side Thus according to the Śulbasūtrakāra, the sides of the square 20 aratnis (480 angulas) long Connect this mid-point to the south-west and the north-west corners so as to obtain a triangle of $7^1/_2$ sq purusas area

The length of the sides of a square of 15 sq purusas area is actually 464 ang -24 tilas and its mid-point is corner Details of giving the layout of a square by using a cord of twice the length of the side of the square are given below while describing

116 BŚS 1 30-35

117 MŚS 10 3-6-3

Indological Truths

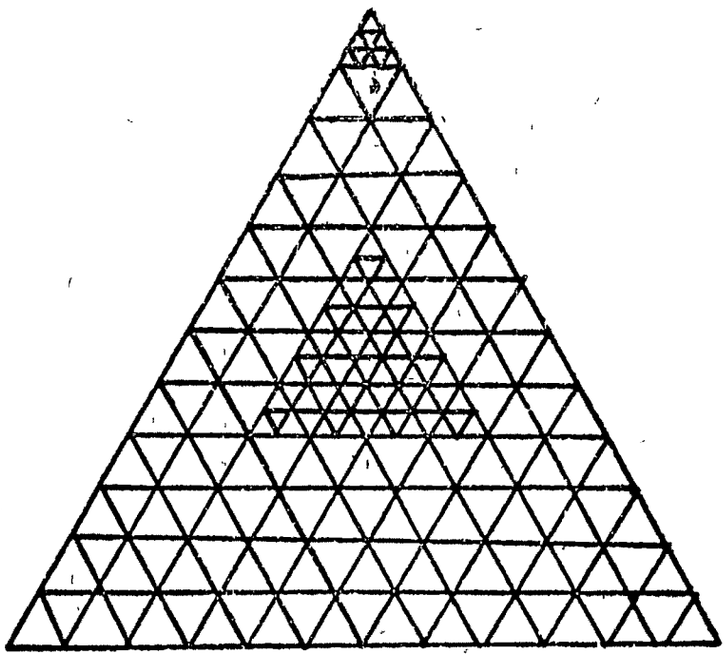

Fig. J Prauga Citi, First Layer

Bṛhatī	Brickt	127
Pāda	Bricks	64
Navamī	Bricks	9
	Sum =	200

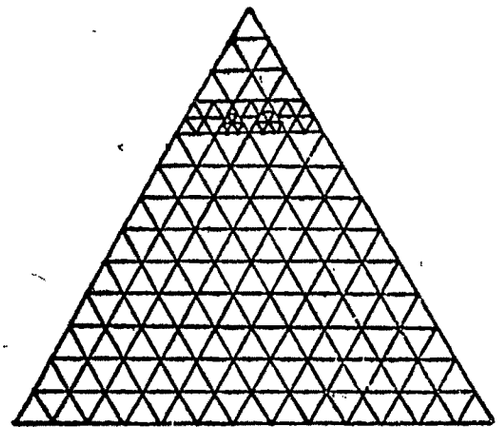

Fig. K Prauga Citi,
Second Layer

Bṛhatī	Bricks	162
Pāda	Bricks	20
Navamī	Bricks	18
		200

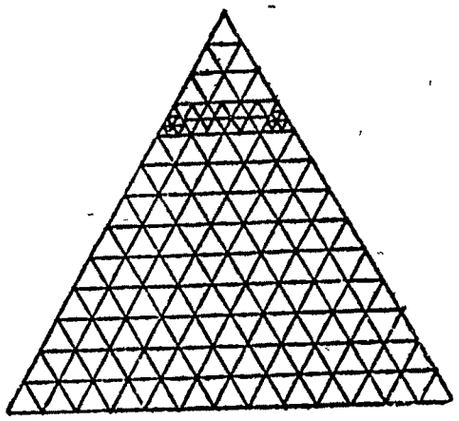

Fig. L Prauga Citi, Second Layer,
(Alternate Arrangement)

Indological Truths

the layout for the ubhayataḥ Prauga cıtı The same procedure ıs followed here to draw the square

Thc prauga cıtı ın thc first layer

In the 1st row on each sıde - B_2-2		total 2
In the 2nd row on each sıde - B_2-6		total 6
In thc 3rd, 10th row on cach sıdc (ı c 16 rows) - B_1-88 B_2-16		total 104
In the 11th row on each sıde - B_2-42		total 42
In the 12th row on each sıde - B_2-46		total 46
	Total B1=8 8 B_2=112	200

Second layer

(a) In the apex B_4	1
(b) In the western end (base), vertıces and bases alternately turned ın opposıte dırectıonB_4	47
(c) In between there are 11 rows south-north of whıch sıdes are fılled wıth B_2s B_2	22
(d) In the centre of the mıddle row B_3-2, B_4-2	4
(e) In the 4th and 5th row 3 B_1s are replaced by 6 B_2s cachB_2	12
(f) In the remaınıng space B_1	114
B_1-114, B_2-34	200
B_3-2, B_4-50	

The construction of a fire-altar in the form of a Rhombus (Ubhayatā Prauga):[118]

A fire-altar ın the form of a rhombus ıs to be constructedas follows

A rhombus cqual ın area to thc (scvcn-fold) fırc-altar wıth (two) aratnıs and (one) pradeśa (ı e $7^1/_2$ sq. pu) ıs laıd As ın the case of fire-altar ın the form of ısosceles trıangle, brıcks and theır varıatıons are to be made wıth the nınth part of the breadth of the ıectangle The placement of brıcks ın the first layer ıs the same

118 BŚS 4-111-117

Indological Truths

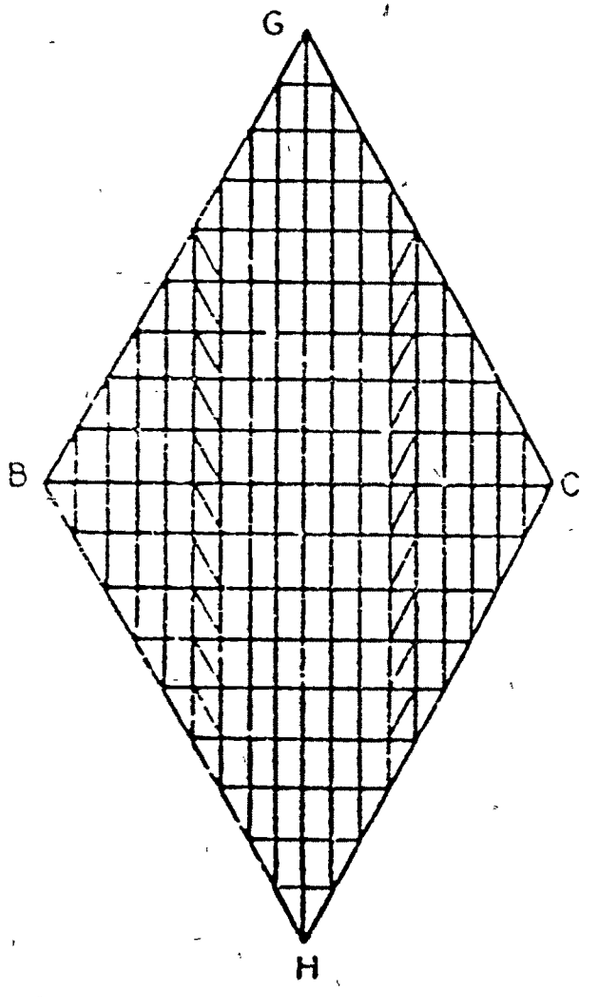

Fig. 57. Arrangement of bricks in the rhombus fire-altar—1st layer.

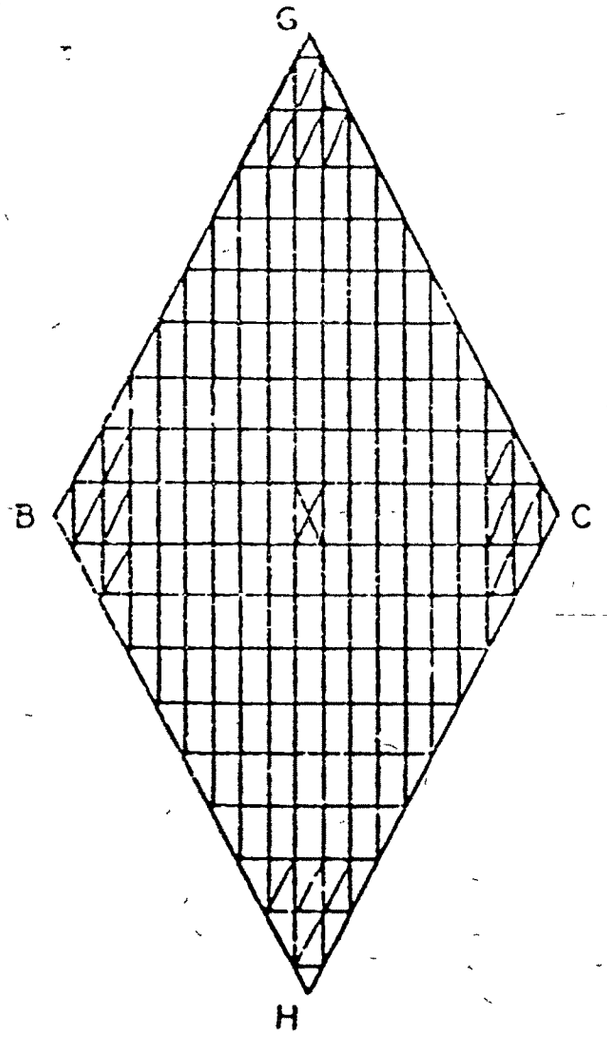

Fig. 58. Arrangement of bricks in the rhombus fire-altar—2nd layer.

Indological Truths

as before (as that of the isosceles triangle) In the second layer, 2 (short based) quarter brick are to be placed in the spaces and 2 (wide-based) quarter bricks at the meeting places (of the two isosceles triangles) 4-quarter bricks- 2 wide-based (dīrghapādhyā) and 2 of the other type (Śulpādyā) are to be placed in the space of the svayamatrnna and half bricks on the two sides The rest of the fire-altar is to be covered with brhatī bricks (with lengths) turned towards east, and the number of (200 bricks) is to be completed with half bricks It may be shown in the figure - 63, as follows

Layout of the Prauga citi according to Baudhāyana:

Draw a square of $7^1/_2$ sq purusa area The length of its side is 328 angulas and $21^1/_2$ tilas Take a cord of $1^1/_2$ times the length of the sides of the square to be drawn, that is 492 angulas and $32^1/_4$ tilas long The cord is divided into two lengths $^{13}/_{12}$x328 ang $21^1/_2$ tilas Mark this point on the cord

Drive two pegs along the prācī, the east-west centre line at a distance of 328 ang $21^1/_2$ tilas Fasten the ends of the cord to these two pegs and stretch it towards the south, holding the mark in the hand The side of the length 136 ang -$31^1/_2$ tila is extended further to 164 ang $10^3/_4$ tila Drive a peg at this point Repeat the procedure on the north side Reverse the ends of the cord and repeat the above procedure towards the west A square of sides of length equal to 328 ang -$21^1/_2$ tila is obtained [119]

Draw another square of the same area and in the contact of the first square and towards the east of it A rectangle is obtained with the east-west length equal to 657 ang -9 tila and the north-south length equal to 328 ang $21^1/_2$ tila Drive pegs at the mid-points of all the four sides of this rectangle A cord joining these pegs gives a rhombus of the area equal to $7^1/_2$ sq purusas [120]

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119 BSS 1 42-44

120 Ibid 1 57

Indological Truths

Arrangement of Bricks:

Size of Bricks-

Rectangular bricks are to be made such that their length is equal to the ninth part of the width of the citi and the width of the brick is to be equal to half its length Ardhyās and pādyās of this brick are also to be made

Arrangement of bricks in the first layer [121]

Two ardhyā bricks are to be placed at each of the corners of the citi Remaining area is to be covered with brhatī bricks along with their ardhyās and pādyās so as to make the total number of bricks equal to 200

Arrangement of second layer

Two Śulapādyās are to be placed in the eastern and western corners of the citi a dīrghapādyā at each end of the line in which the two praugas forming the ubhayatah-prauga meet that is at the southern and the northern corners of the citi Four bricks, two dīrghapādyās and two Śulapādyās are to be placed at the centre of the citi The rest of the agnīs to be covered by brhatī bricks and their ardhyās and pādyās so as to make the total number of bricks in the layer equal to 200

The arrangement of bricks given for the construction of the first layer is to be followed for the construction of the third and the fifth layer The arrangement of bricks of the second layer is to be followed for the construction of the fourth layer of the citi

Bricks	Bṛhatī 36 aṅg.-17 tila	Ardhyā	Dīrghapāda	Śulbapāda	Total
First layer	124	76	–	–	200
Second layer	128	64	4	4	200

In Āpastamba[122] & Mānava[123] the layout of this citi is similar to one given while describing it according to the Baudhāyana Sulbasūtra

121 Ibid 4-113-117

122 ĀŚS 12 12 15

123 MŚS 10 3 6 4

Indological Truths

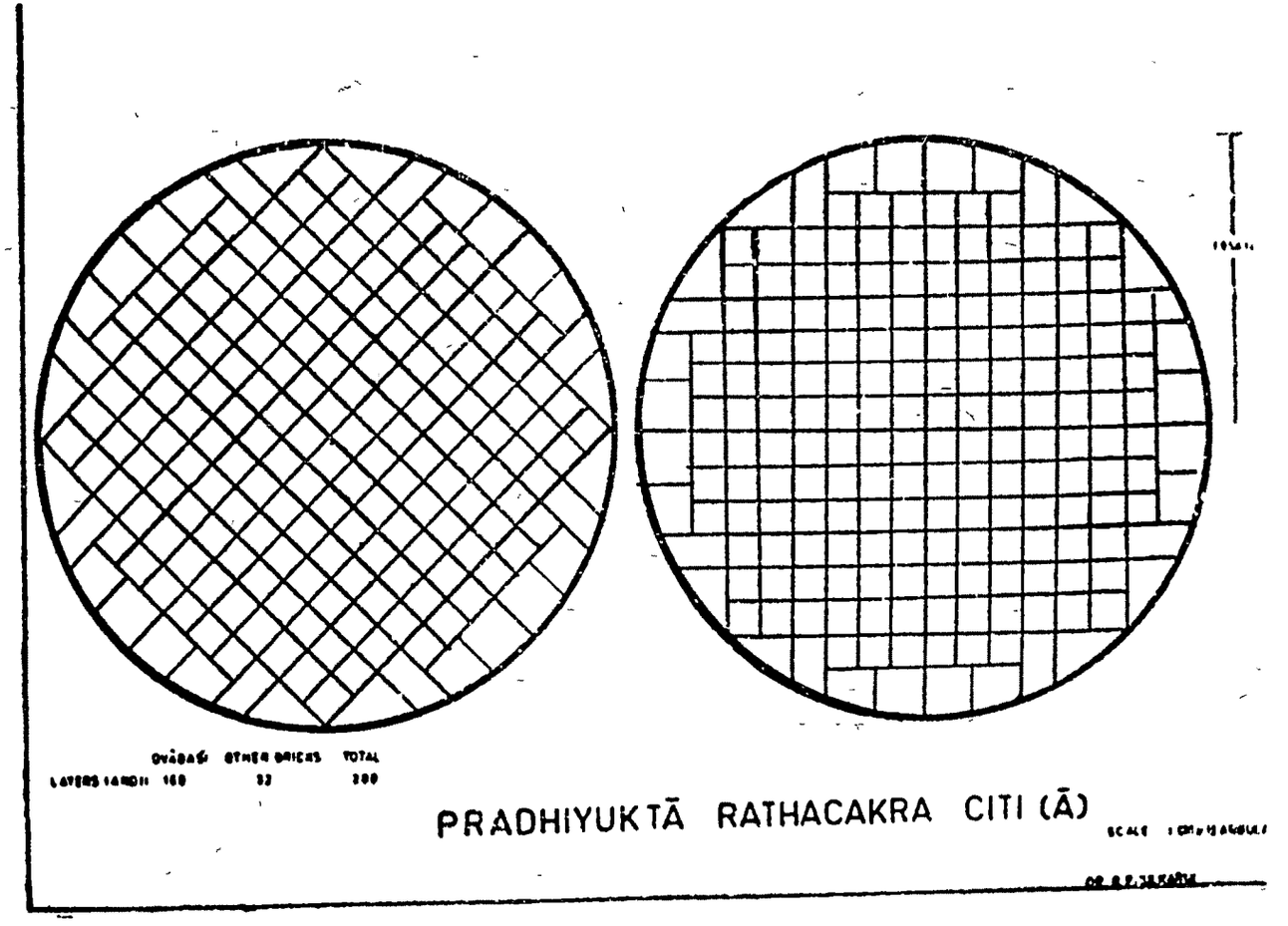

Fig 64

Fig. 6 Pradhiyuktā Rathacakra Citi

Indological Truths

A construction of a fire-altar in the form of chariot wheel type - Pradhiyuktā Rathacakra citi:

Fire-altar in the form of a chariot-wheel are of two types- (a) a square piece with four circular segments attached one on each side so as to give the wheel structure a circular shape, and (b) a circular wheel provided with spokes Both types are used for sacrificial purposes and are described in Baudhāyana Śulbasūtra

"A circle of area equal to that of the (seven-fold) fire-altar with (two) aratnis and (one) pradeśa is made, the largest possible square is iscribed in it,and bricks are made with the twelfth part of its side 6 of these (bricks) are placed in each circular segment and the remaining space (of the segment) is divided into 8 parts The other layer is to be so oriented that the corners (of the square) lie in the centres of the segments (of the first layer) "[124] This can be shown in the figure - 64

This method has been given in rule 2-9 of Baudhāyana The figure shows the required circle of area $7^1/_2$ sq pu within which is drawn a largest possible square ABCD The space bounded by each side of the square and the arc of the circle is called pradhi (segment) there are four such segments

Placement of bricks:

144 bricks of the type mentioned above can be placed within the square ABCD In the segments 6 such bricks are placed adjoining the middle side of the square and the remaining space is divided into 8 parts as in the figure (a) & (b) This each segment contains 14 bricks and four segments account for 56 bricks making the total number 200

Dvārakantha (commutation) gives the measurements of these eight bricks as follows

1) The corner brick abg	ab=33 ang 7 ti
	bg=29 ang + 3 ti
	ag=42 ang - 3 ti
2) The 4 sided brick bchg	bc=33 ang - 7 ti
	ch=42 ang + 11 ti

124 BŚS 5-1, 5-8

Indological Truths

	hg=36 ang + 26 ti
	bg=26 ang + 3 ti
3) The 4 sided brick deih	dc=33 ang - 7 ti
	ei=30 ang =16 ti
	ih=34 ang
	hd=$20^{1}/_{2}$ ang
4) The 4 sided brick efji	ef = 33 ang - 7 ti
	fj=$32^{1}/_{2}$ ang
	ji=33 ang - 4 ti
	ei-30 ang -16 ti

He eg hg, ih and jc are curved

In the second layer the inscribed square is turned such that its corner lies in the centre of each segment of the first layer in order to avoid the overlapping of the bricks between layers

In ĀŚS [125] the layout of this citi is slightly different This can be tabulated as follows

First layer		
	Dvādaśī	124
	Ardhyā	4
	Pāda	72
	Sum	200
Second layer		
	Trayodaśī	158
	Ardhyā	2
	Pāda	40
	Sum	200

125 ĀŚS 12-16-17, 13 1-5

Indological Truths

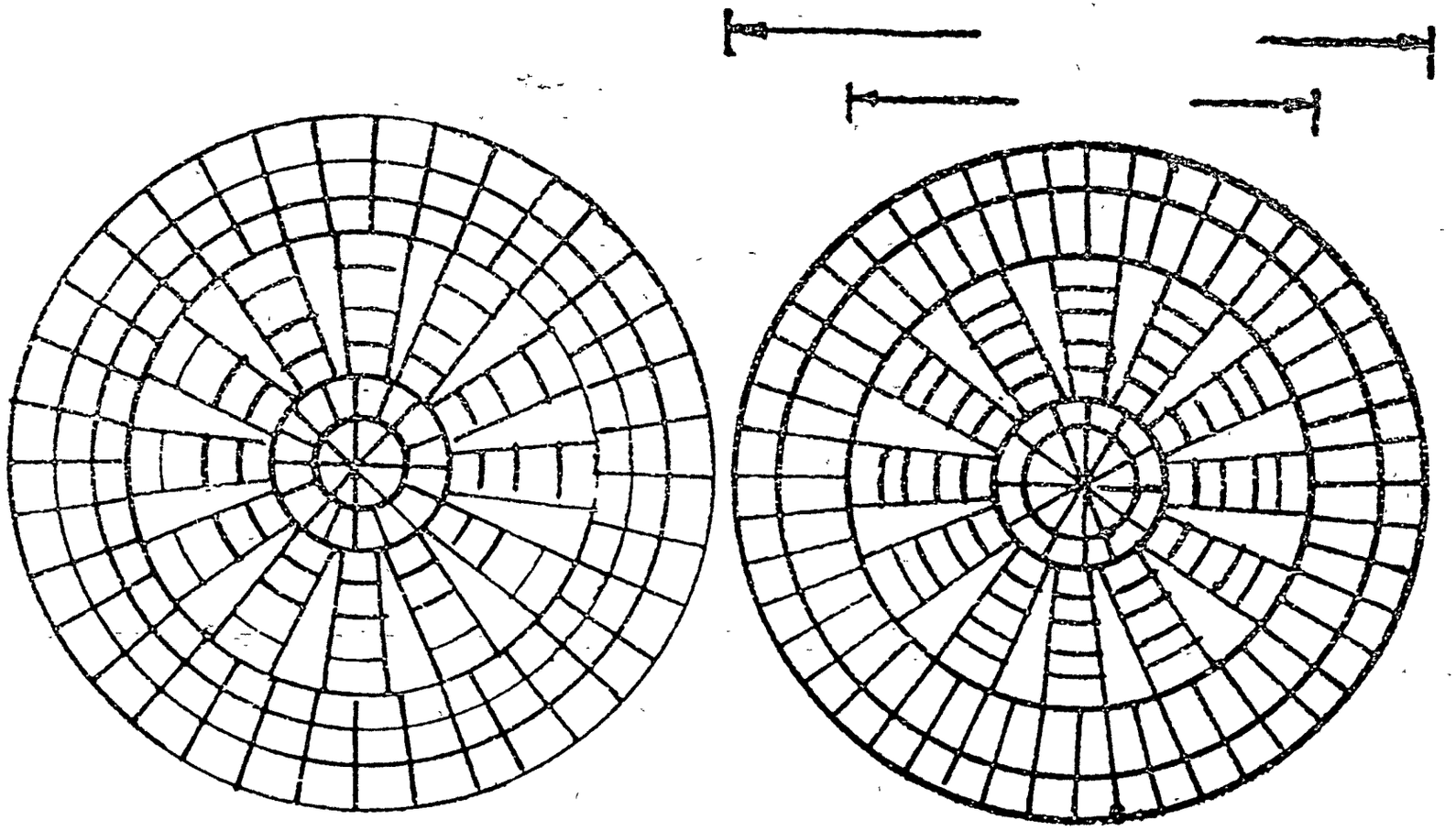

Fig. 66 Sārā-Rathacakra Citi

Indological Truths

In Mānava Śulbasūtra this type of Rathacakra citi is not mentioned, i e only Rathacakra citi with spokes is mentioned Kātyāyana followed the Baudhāyana's method

Another type - Chariot wheel with spokes - Type II

(Sāra Rathacakra type)

Baudhāyana has described another type of chariot-wheel fire-altar [126] This type of fire-altar is constructed as follows

Square bricks of area equal to the fifteenth part of half a square purusa are made for purpose of measurement 225 of such bricks is accomplished (15^2=225, 15 is the square number) Each area of the square brick is $^1/_{30}$ sq pu Thus the total area of the fire-altar is $^{15}/_2$ sq pu

A chariot of wheel with spokes consists of the central circular part, the nave, the spokes and outer circular rim, the felly The spokes connecting the nave and the felly alternate with empty spaces as shown in the figure - 65

An area equivalent to the empty spaces between spokes is first added and then removed This area is here taken to be equivalent to that of 64 square bricks of the type described above, probably because 225 plus 64 make 289, a squared number of 17 Hence the direction of arranging 289 bricks in the form of a square so that each side contains 17 bricks This is done in two stages, at first, 256 bricks are arranged in a square, each side containing 16 bricks and then 33 bricks 17 plus 16 are placed along two adjoining side In this way square is formed 16 bricks at the centre constitute nave, 64 bricks thereafter constitute the spokes and 64 empty spaces between spokes and the remaining 145 bricks form the felly as shown in the figure - 65

The square shaped nave at its borders is transformed into a circle (by the method previously described) The outer and the inner squares enclosing the felly are transformed into two circles

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126 BŚS 16,6-20

Indological Truths

In the figure (a) square EF & H form the nave Another square IJKL is formed of 144 bricks, centrally placed within ABCD The area between the squares IJKH and EFGH is equivalent to the area of 128 bricks (144-16) half of which, i e 64 is used for making spoken (ara) and the remaining half (64 bricks) for the empty spaces (vedi)

Placement of the bricks in the first layout:[127]

The felly (nemi) is divided into 64 equal parts We have seen that the annular space comprising the spokes and the empty spaces was divided into 32 equal parts, by radial lines These are projected into the felly dividing it at first into 32 equal parts and each part is then equally divided by radial lines confined between the outer and inner circumference Now a concentric circle passing through the middle of these two circumferences of the felly is drawn, dividing its space into 128 parts Note that the area of each part lying outside the middle circumference is different from that lying within

Fact spoke is divided into 4 parts, thereby involving the use of 64 bricks of four different types Finally the nave is divided into 8 equal parts to make the total number of bricks in the first layer 200

Total area of the citi = 108000 sq ang

Area of the felly = 13870-69120 = 69600 sq ang

Area of the nave = 7680 sq ang

Area of the spokes = 30720 sq ang

No of Bricks (first layer)

No of bricks in the felly = 128

No of bricks in the nave = 8

No of bricks in the spokes = 64

Total 200

127 BSS 16-12-14

Indological Truths

Placement of bricks in the second layer:[128]

In the second layer a circle is drawn within the nave at a distance equal to one-fourth of the radius from its inner edge The same is to be done within the felly (at a distance equal to one fourth of the felly's breadth) from the inner circumference After dividing the inner, edge of the felly into 64 equal parts (radial) lines are to be drawn so as to divide the felly into 64 parts The space in each of the spokes is divided into 5 parts from circle (in the nave) to the circle in the felly The space in each interstice of the felly is divided into 2 parts, and there is 1 part in each interstice of the nave The remaining space of the nave is to be divided into 8 parts These are the 16 types of bricks required in the construction of the fire-altar in the form of a chariot wheel with spokes [129]

Area of the bricks in the felly = 138720 - 108000 = 30720 sq ang

Area of the bricks in the felly = 19440 sq ang

Area of the bricks in the spokes = 51840 sq ang

Area of the bricks in the nave = 4320 sq ang

Area of the bricks near the nave = 1680 sq ang

Total = 108000 sq angulas

No of bricks in the felly = 64+32 = 96

No of bricks in the spokes = 16x5 = 80

No of bricks in the nave = 8+16 = 24

Mānava Śulbasūtra[130] explains the construction of this type of fire-altar which covers an area of $10^1/_2$ sq pu This can be explained briefly as follows

Draw a circle of $10^1/_2$ sq purusas area The radius of the circle is 220 angulas This is the outer circle of the rim Draw another circle of 147 angulas radius as in the figure This is the inner circle of the rim Draw two more circles- one of 196 angulas radius and the other of 172 angulas radius These circles divide the width of

128 BSS 5-30-33

129 BŚS 5-34-37

130 MŚS 10 3 6-13-18

Indological Truths

the rim into three parts Draw two additional circles, one of 55 angulas radius and the other of $27^1/_2$ angulas radius They form the hub of the wheel There are 12 spokes Their length is 147-55=92 angulas The width of the spokes near the rim is $42^3/_4$ ang and the width of the open space between spokes near the rim is $34^1/_5$ angulas The corresponding figures near the hub are $27^3/_4$ and five angulas respectively

Area of the space = $^1/_2$ (5+$34^1/_5$) x 92x12 = $21638^1/_5$ sq angulas

= $1^1/_2$ sq purusas

Area of the citi = $10^1/_2$

For the layout of the second layer, the radius of the outer circle of the rim is again 220 angulas and that of the inner circle is 147 anguls The width of the rim is 73 angulas Draw a circle of 196 angulas radius so as to divide the width of the rim in two parts in proportion of 1 2 The width of the rim is thus divided in 24 and 49 angulas The inner circle representing the hub is drawn with the radius of $36^2/_3$ angulas and the outer circle is drawn with the radius of 55 angulas There are again 12 spokes

Another type has an area of $7^1/_2$ sq ang In the first type, it has nave, spokes, and empty inter-spaces between the spokes and rim accounting for the excess In another type its rim becomes equal to the breadth of spokes and the diameter of the circle and bricks used are made by the third part The nave is drawn with $^1/_2$ purusa, it has space for grass, the rim is larger than spokes by $^3/_6$ purusa, it is the dwelling of Visnu it has the measure of $324^1/_2$ angulas and a circle is made in the middle with its 20th part The bricks in the first layer of the chariot wheel are known to be 344 In the second layer, there are 24 more bricks, five-cornered and three cornered bricks are used in the joints of the rim and spokes The five layers of the chariot-wheel fire-altar are filled up with 1,768 bricks [131]

131 MŚS 15-19, 16-1 7

Indological Truths

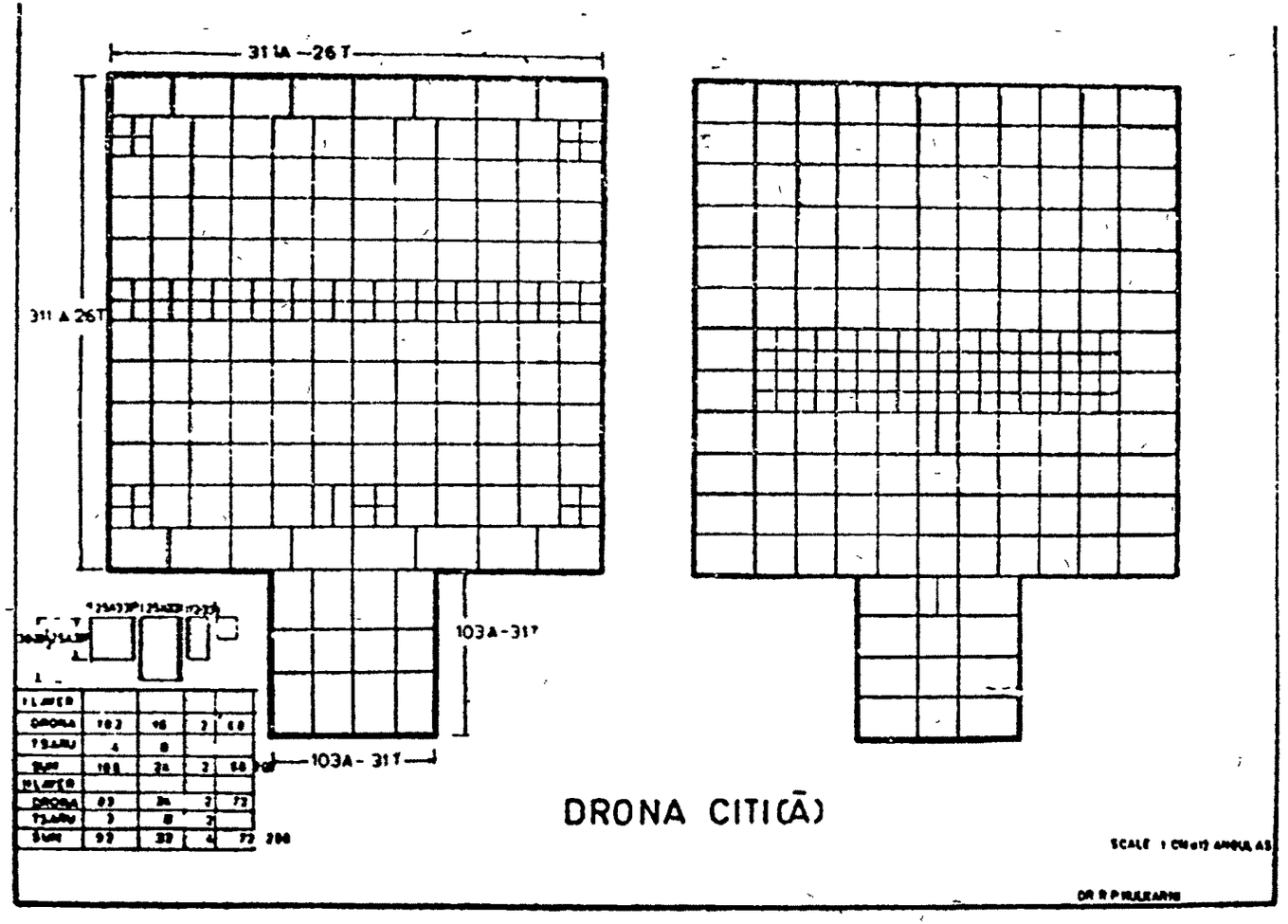

Fig. 8 Droṇa Citi

Indological Truths

Āpastamba refers to the same type of rathacakracit, as discussed in detail by BŚS [132]

The construction of a fire-altar in the form of a square trough (Droṇacit) - Type I.

Fire altars in the form of a trough (Dronacit) are of two types the square shaped and circular shaped In the absence of any distinction between the two, both are taken into consideration and described Construction of one type of trough (dronacit) is explained by Bodhāyana as follows [133]

The body of Dronacit is a square of side equal

Layout of the Citi:

The length of sides of the large square representing a drona is $2^2/_3$ purusa (320 angulas) A small rectangle representing the handle (tsaru) of the drona is placed behind (towards the west) and in contact with the large square The length of the east-west side of this rectangle is 70 angulas and that of the north-south side is 80 angulas The area of these two is 320x320+70x80=102400+5600=108000 sq angulas, $7^1/_2$ sq purusas

Drive two pegs on the central east-west line a distance of 320 angulas from each other Take a cord $1^1/_2$ times this length (480 angulas) and divide it into two, one side being of the length $^5/_4$x320=400 sq ang and another side of the length $^3/_4$x320=400 angulas Put a mark at this point Put another mark at one-half the length of the side of the square, equal to 160 angulas is located on the ground Repeat the procedure towards the north Reverse the ends of the cord and repeat the above towards the west A square of the desired dimensions is obtained

Extend prācī towards the west of teh westside of the square Drive a peg (1) at the middle of the west side Drive another peg (2) at a distance of 70 angulas along prācī from this peg Take a cord of 80 angulas length Fasten its both ends to the peg at the mid-point of the western side of the square Stretch the cord towards

132 ĀSS 12-9-13-1 3

133 BŚS 17

Indological Truths

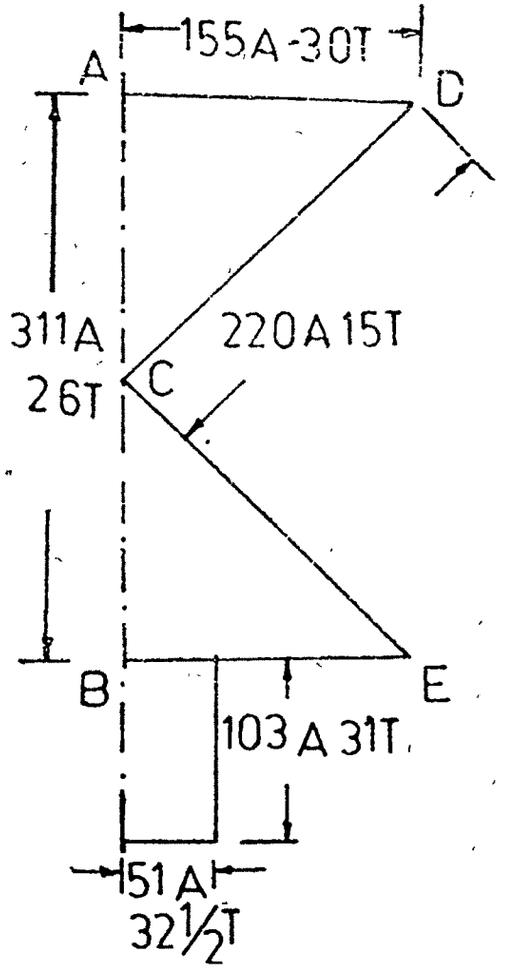

Fig 7 Method of giving Layout of Droṇa Citi

Indological Truths

the south and drive a peg (3) where the mid-point of the cord is located Repeat the procedure towards the north Drive two pegs (5 and 6), one towards the east and the other towards the west at equal distance from the peg 2 on prācī Two ends of the cord of 80 angulas length are fastened to the two pegs 5 and 6 and the cord stretched towards the south by holding the cord at its mid points Make a mark on the ground where the mid-point is located (7) Unfasten the ends of the cord from the pegs 5 and 6 and fasten both the ends on the peg 2 and stretch it towards the south so as to align along the mark 7, by holding it at its mid-point Drive a peg (8) where the mid-point of the cord is located Repeat the procedure towards the north A rectangle of the east-west side of 70 angulas length and north-south side of 80 angulas is obtained

Layout of Citi according to Mānava[134] **:**

The area of the handle (tsaru) is one-tenth of that of the drona The area of the drona is 98182 sq ang and that of the handle is 9818 sq angulas The total area is 108000 sq angulas The length of the sides of the square-shaped drona is 313 ang 10 tila The length of the sides of the square taken for the layout is 312 angulas, as it is to be divisible by 13 angulas, size of bricks The handle is rectangular, its width is 109 angulas and the east-west length 90 angulas The area of this rectangle is 9810 sq ang The length and the width dimensions are not divisible by 13, the size of the bricks It is therefore, suggested that the sides of this rectangle may be 104 angulas and the east-west length of 91 angulas The area is 9464 sq angulas The alternative dimensions are $110^1/_2$x91 angulas The area of this rectangle is $10055^1/_2$ sq angulas

A square of the sides 312 angulas long is drawn by using a cord of twice the length of the side of the square, as already described The rectangle to its west is also drawn by the method described for giving layout of the handle of the drona according to B Ś S (1-36-40)

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134 MŚS 10369

Indological Truths

Layout of Citi according to Āpastamba:[135]

The area of the handle is one-tenth of the whole of the citi The area of the handle is 10800 sq angulas and that of the body is 97200 sq ang The length of the sides of the square-shaped body is 311 ang 26 tila Place another square in contact with the western border of the square representing the body The length of the sides of this square is 103 ang 31 tilas

Draw the square representing the body of the citi by using a cord of the length equal to 311 ang 26 tila x ($^1/_2$+$^1/_2$) Divide it into two parts one being 155 ang 30 tila and another being 220 ang 15 tila

Along the east-west centre line place two pegs A & B at a distance of 311 ang 26 tila Spread the cord along the prācī, one end being at the peg A Drive a peg C at one half the distance 155 ang -30 tila from peg A Fasten one end of the cord to peg A and another to peg C Stretch the cord towards the south by holding the mark in hand and drive a peg D where this mark is located on the ground Unfasten the knot of peg A and fasten it to peg B and repeat the procedure towards the north The square of the required dimensions is obtained

The different type of bricks are as follows

B_1- square bricks of side one - sixth, pu sasthi - 20x20 sq ang

B_2 - one-sixth brick longer by half (adhyardhā, sasthi) - 30x20 sq ang

B_3 - half bricks, i e half of sasthi - 20x10 sq ang

B_4 - square bricks of side one-fourth - pu caturthi - 30x30 sq ang

Placement of bricks in First layer:

6 sasthi bricks are placed on each of the two parts of the western side (BE and HC) between the handle and the corner the rest of the fire-altar is to be covered with brhatī (i e adhyardhā) bricks, and the number (of 200 bricks) is to be completed with half bricks (160 in the body and 12 in the handle) The placement of bricks is as shown in the figure - 66

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135 ĀŚS 13-6-25

Indological Truths

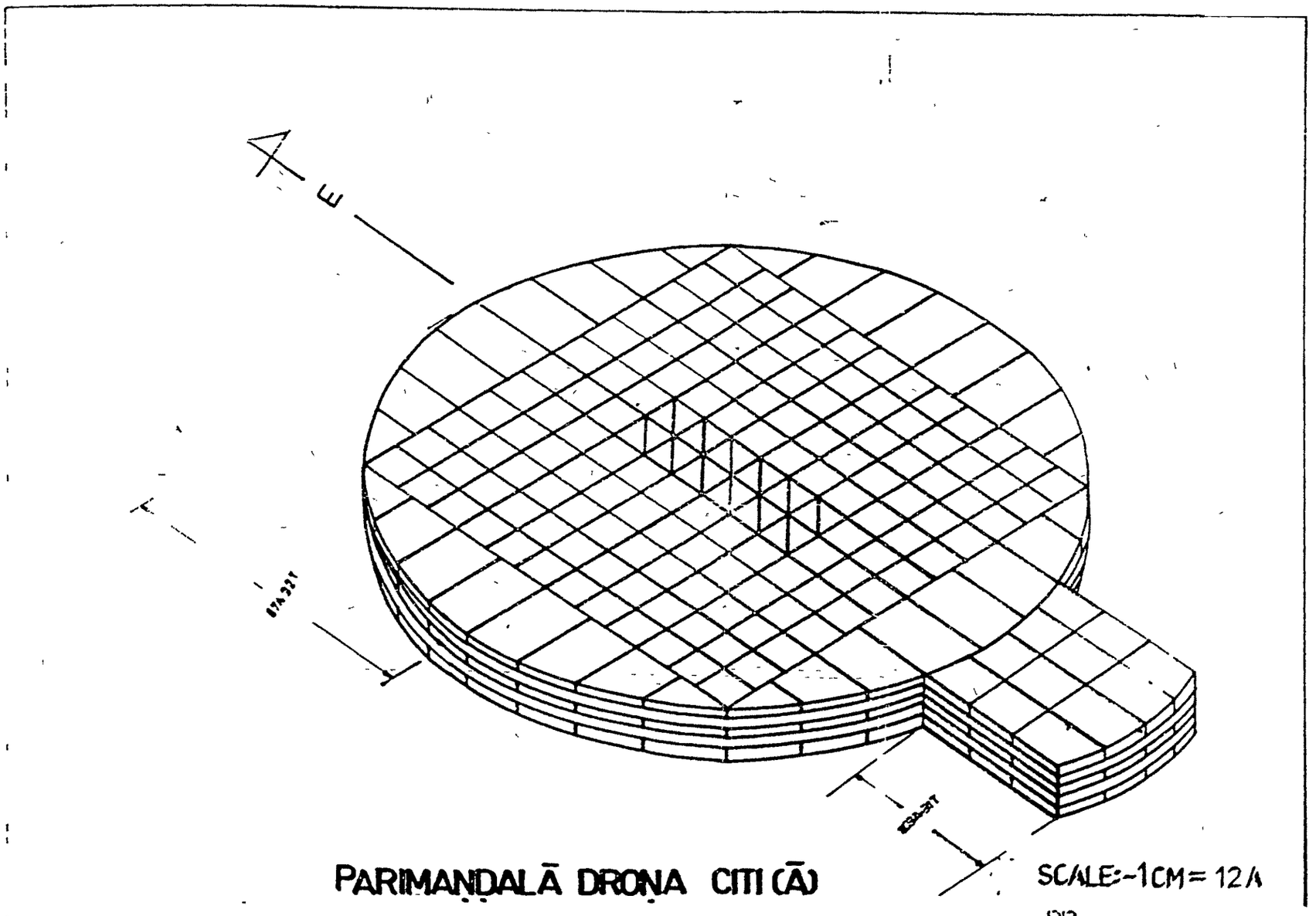

Fig 6

Indological Truths

Arrangement of bricks in second layer:

A brick of adyardhā[136] brick (30x20 ang) size turned towards the north, is to be placed in the south-east corner of the ātman Another brick of the same size is to be placed in the north-east corner On the eastern edge of the ātman, between the two bricks mentioned above, square bricks of the size 20x20 ang are to be placed (13 bricks are accommodated) Square bricks of 30 ang side are to be placed on the south and north edges On the east side of the handle on both sides, two bricks of size 30x30 ang are to be placed To the west of these two place on both the sides two bricks of the size 20x30 ang turned away from each other To the west of the square bricks of 30 ang sides and in the middle of the handle place two square shaped bricks of sides of 20 ang the one to the east of the other The remaining of the Agni is to be covered with the bricks of the size 20x30 ang The total number of bricks is to be made equal to 200 by using bricks of the size 20x10 ang

Bricks	Location	Caturthi 30x30 ang.	Sasthā 20x20 aṅg	Brhatī 20x30 aṅg	Ardyā 20x19 ang
First	Drona	–	6	160	20
layer	Tsaru	–	6	4	4
	Sum	–	12	164	24 =200
Second	Drona	20	13	120	26
Layer	Tsaru	2	6	2	1
	Sum	22	19	122	37 =200

Circular Droṇa cit - Type II:

BŚS mentioned about the construction of trough in the form of a circle[137] 120 square bricks each $^1/_{16}$ of a square purusa give the area of teh seven fold fire-altar with two aratnis and one pradeśa One of them is taken away, and the area equivalent to the remaining (119 bricks) is transformed into a circle The area of the fire-altar equals 10800 sq ang After deducting the area of I sodaśi brick of 900 sq ang the

136 BŚS 6-11-22

137 BŚS 18-1-15

Indological Truths

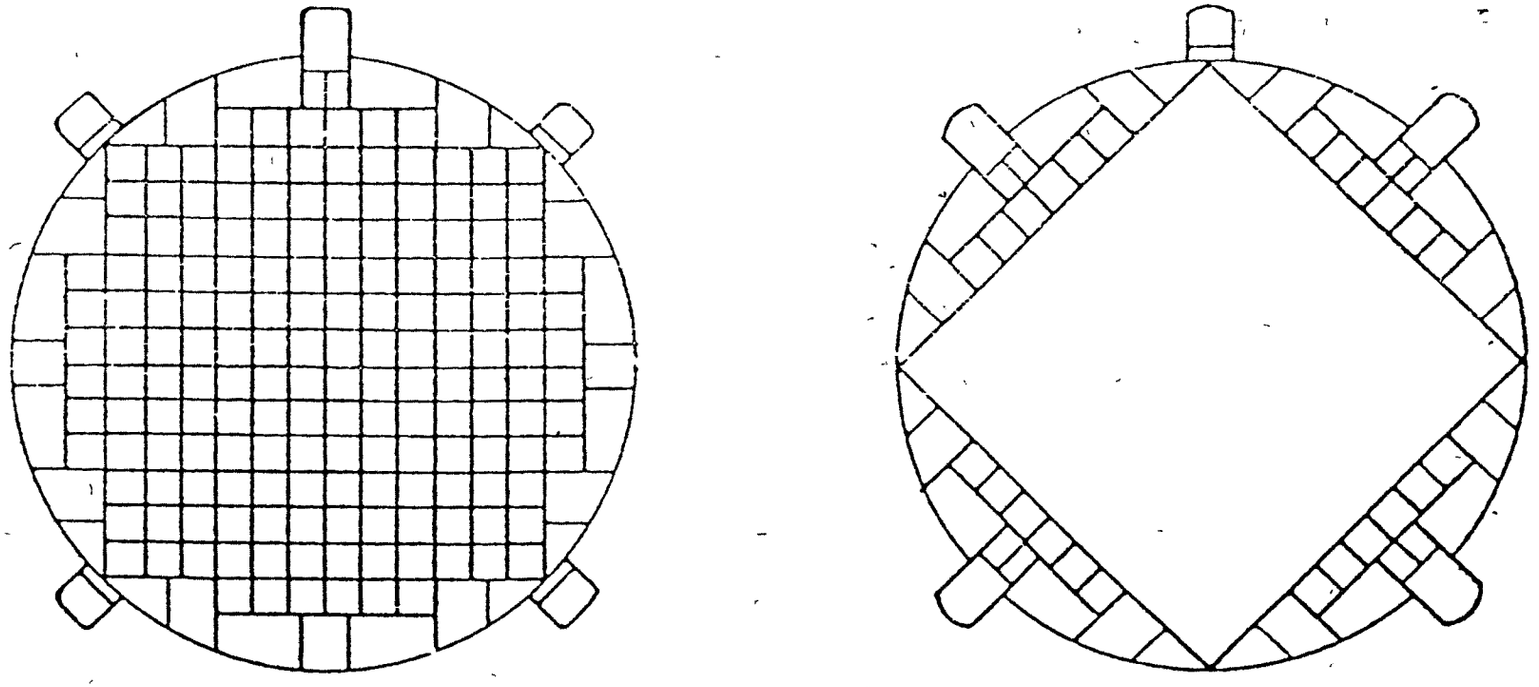

Fig. 88. Arrangement of bricks in the circular *kūrmacit*,—
(a) 1st layer ; (b) 2nd layer.

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balance of 107,000 sq ang is converted into a square of which the side obtained by taking square root works out to 327 ang 9 tila

Next step into convert the above mentioned square into a circle by the method given in sütra B Ś S 2 9 and already applied in the case of the fire-altar in the form of the chariot-wheel As shown in the figure let ABCD be the square of side equal to 327 ang 9 tila EFGH is the sodaśi brick placed at the middle of the eastern side AD of the square With 'O' as the centre and OM as radius a circle equal in area of square ABCD is drawn, cutting EFGH by the curved line IJ The part of the sodasi brick IFGF cut by the circle is transferred to the top of remaining portion, as KEHL, now KIJH whose area remains the same as that of a sodaśi brick represents the handle of the circular trough

The value of OM, the radium of the circle can be calculated from the formula

$OM=a/6\ (2+\sqrt{2})$ where a=AB=327 ang 9 ti

Putting $\sqrt{2}$=1 414 OM works out to 186 ang 7 tila

Alternatively, if AO=r

$2r^2=a^2=107100$ sq ang

r=231 ang 13 ti

$MN=1/3\ (r-9/2) = 1/3$ (231 ang 13 ti -163 ang 21 ti)

$=1/3$ (67 ang 26 ti) - 22 ang 20 ti

OM=163 ang 21 ti+22 ang 20 ti =186 ang 7 ti

Arrangements of bricks in the first layer:

A square PQRS as large as possible is enscribed within the circle of the fire-altar as constructed above The side P & is given by

$$PQ^2=2r^2=\frac{2\pi r^2\ (67\text{ang }26\text{ti})}{\pi}\ \frac{2x107100}{}$$

or PQ=261 ang 6 ti (for p=3 14)

Square bricks are made with side equal to $1/12$ PQ i e 2) ang 26 til (i e $1/12$th

Indological Truths

of 261 ang 6 ti) The inscribed square PQRS is filled with 144 such bricks 6 such bricks are placed in each of the four segments in the middle of, and touching the square 24 such bricks are placed in the segments The remaining space in each segment is divided into 7 parts [138]

Arrangement of bricks in the second layer:[139]

In the second layer, the inscribed square is turned such that the corners point towards intermediate directions The square is filled with 144 one-twelfth bricks as before and 24 similar bricks are placed in the segments The remaining space in each segment is also divided into 7 parts as in the first layer, making the number 28 To avoid the overlapping of edges, the prādhi madhyama brick is placed in the handle, and the space below is equally divided The total number aggregates to 198 The deficit is met replacing 2 one-twelfth bricks in the square by half bricks The arrangements of bricks in the second layer shown in a table as follows

Bricks in Circumscribed square		**Bricks in segments**		**Bricks in spout**	**Total**
Square Bricks	Ardhyā	Square Bricks 30x30 ang	Other Brikes	2	
21 ang-$25^1/_2$ tilax21 ang 142	$25^1/_2$ tila 4	6x4 =24		7x4 =28	200

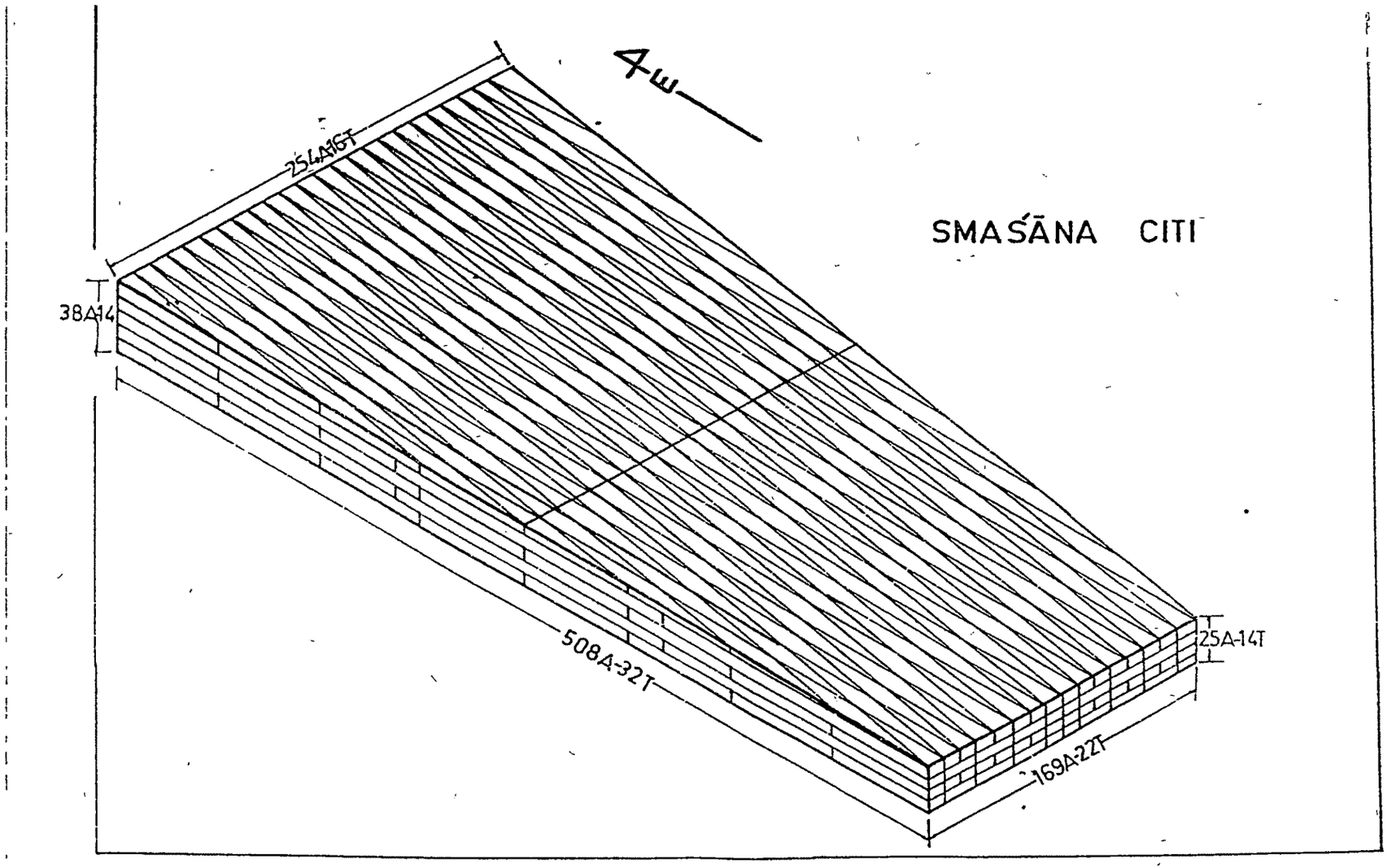
In Āpastamba's Dronacit,[140] the relative areas of the handle and the body of the trough are different from those prescribed by Baudhāyana The area of the seven fold fire-altar being 10,8000 sq ang The area of the square body is 9 times that of the square handle and therefore the side of the handle is one-third of the side of the body The sides are,

138 BŚS 7-1-14

139 BŚS 7 7-12

140 ĀŚS 13 4-16

Indological Truths



~~VGM 24~~

Fig 70

Indological Truths

The side of the body=311 ang 26 18 ti

The side of the handle=103 ang 31 28 ti

The arrangement of bricks in the first and second layers for which the direction in the sütras are quite clear

In Mānava's Dronacit[141] there is a handle which has an area one-tenth of the original fire-altar For the circular dronacit, it is measured with one-twentieth part of the square (i e 22 angulas) After the area inside and outside the squares is measured out, it is divided into ten equal parts, there should be triangle in the corner and joints in alternative layers 1000 bricks, each brick must have an area one-fifteeth part of the square (of side 72 angulas), bricks of one and half times (adhyardhā) are also made, then each layer is known to have 200 bricks

Layout of citi according to Mānava [142]

The area of a square of the sides two bāhus long in 5184 sq angulas The area of such 20 squares is 103680 sq angulas Draw a square of this area The length of the sides of the square is 322 angulas Draw a circle circumscribing this square The radius of this circle is equal to one-half the diagonal of the square which is equal to 227 ang $23^1/_2$ tila The area of the circle is 162887 sq angulas Area of the handle is 2568 sq angulas Total area, however, is 108000 sq ang Arrangement of bricks is not given by Śulbasütrakāra, but it may be similar to that described in the BŚS for the circular Drona citi

The construction of fire-altar in the form of a PYRE (ŚMAŚĀNACITI)[143]

The fire-altar in the form of a pyre, is a trapezium BŚS explains elaborately about the construction as follows

The entire area of the fire-altar is divided into 15 square parts To do this, a rectangle is made with its length equal to thrice the side of the square part and breadth

141 MŚS 15 6-10

142 MŚS 10 3 6-2-8

143 BŚS 8-1-17

Indological Truths

equal to half of the side of the square part Lines are drawn from the middle of its eastern side to the two western corners and the two outer parts are removed (so as to obtain an isosceles triangle as in the figure) This is then divided into ten parts

As in the figure - 68 the fire-altar is in the form of a trapezium (ABCD), of which the western side BC is 170 ang -12 tila, the eastern side 245 ang +16 tila and the height (i e distance between AD and BC) is 509 ang -2 tila

Let be the unit of measurement, according to rule 19 2, $P^2=1/15$ of the area of the fire-altar $=1/15 \times 15/2$ sq pu $=1/2$ sq pu

$P=1/\sqrt{2}$ pu $=\sqrt{7200}$ ang $=84$ ang 28 tila

If BC=2p (=170 ang 12 tila) AD=3p=(254 ang +16 tila) height the distance between AD and BC is 6p (509-2 tila)

$2p \times 6p + P/2 \times 6p = 15p^2 = 15/2$ sq pu $= 7 1/2$ sq pu which satisfies the area of other agiksetra

First layer

For purpose of making the bricks, a rectangle ABCD is formed such that its length AB is thrice the square part and breadth (BC) equal to half of the side of square part The sides EB, EC and BC are each divided into 4 equal parts by marking 3 equidistant points on each side The points on the sides are joined with those on the base as shown in the figure so as to obtain 4 isosceles triangle at the base and 6 double isosceles triangle above them The entire fire-altar is composed of 20 of them (of such isosceles triangle)[144]

The width of the eastside of citi is 254 ang 16 tilas and that of the western side is 169 ang 22 tiles Divide the eastside into 24 equal parts and the westside into 16 equal parts The length of each equal parts on the eastern and the western sides is same, i e 10 ang 21 tilas Divide the northern side of the citi into eight equal parts Join the first eight points on the eastern side, beginning from the north-east corner to the eight parts of the northern line, including the north-west corner The

144 BŚS 19-3-4

Indological Truths

remaining 16 points are joined to the 16 parts of the western side of the citi as shown in the drawing These lines are parallel to the northern side Repeat this procedure from the south-east corner so that the line parallel to the southern side of the citi are obtained In the middle of the length of the trapezium representing the citi drawn a north-south line Arrange the bricks as given above This is the first layer

Second layer [145]

In the second layer one of the (five) isosceles triangles (into which the entire fire-altar can be divided) is to be vertically bisected Each half is divided into 6 parts These two (half isosceles triangles each divided into 6 parts) are to be placed on the either side (i e the southern and the northern side of the fire-altar) Bricks of length equal to the one third (side of the square part) are to be made, and then half of such bricks by transverse bisection

After placing them (the half bricks) on the two ends (the eastern and the western) the rest of the fire-altar is to be covered with the brhatī bricks turned towards east, and the number (of 200 bricks) is to be completed with half bricks The height of the fire-altar is to be increased by one-fifth (of the jānu, i e $6^2/_5$ ang) The whole of it (the height including the added 5th part) is divided into three parts and bricks are made with the fourth or the ninth or the fourteenth part of the two of these three parts With these bricks, 4 or 9 or 14 layer are made, the remaining layer (of thickness equal to one-third of the height) is diagonally cut in the downward direction and half of it removed Its division is exact, larger and smaller bricks are taken according as those fit

The sides of the trapezium may be summarised as follows

Length of the east side= 3 (8 ang - 28 tila)= 254 ang 16 tila

Length of the west side = 2 (84 ang 28 tila)= 169 ang -22 tila

Distance between the east & the west side = 6 (84 ang - 28 tila) = 510 ang 32 tila

145 BŚS 19 5-11

Indological Truths

Śmaśāna citi according to Āpastamba[146]:

Layout of Citi-

The layout and the arrangement of bricks are similar to those described for Drona citi in Bau Ś S Draw a square of the sides 328 sq ang $21^1/_2$ long The area of this square is 108000 sq angulas The square is drawn by the method described to give the layout of the body of the drona citi

Sizes of the Bricks

Square-shaped bricks of the sides equal to $^1/_{12}$th the length of the sides of the square of the citis are prepared This is the Dvādaśī brick Bricks of other sizes are also prepared

Dvādaśi bricks=27 ang 13 tila x 27 ang 13 tila

Adhyardhā bricks=41 ang $2^1/_2$ tila x 27 ang 13 tila

Ardhyā bricks=27 ang 13 tila x 13 ang $23^1/_2$ tila

Pāda bricks=13 ang $23^1/_2$ tila x 13 ang $23^1/_2$ tila

Arrangement of bricks in the First layer

Place adhyardhā bricks, oriented towards the south, along the eastern and the western borders of the citi The remaining area is to be filled with Dvādaśī bricks Pāda bricks are to be added so as to make the total number of bricks equal to 200

Arrangement of bricks in the second layer.

Place adhyardhā bricks, oriented towards the south, along the southern and the northern borders of the citi. The remaining are is to be filled with Dvādaśi bricks Pāda and adhyardhā bricks are to be used to obtain the total number of bricks equal to 200

Bricks	Dvādaśī	Adhyardha	Ardha	Pāda
First & Second layers	70	32	6	92=200

146 ĀŚS 14-9-15

Indological Truths

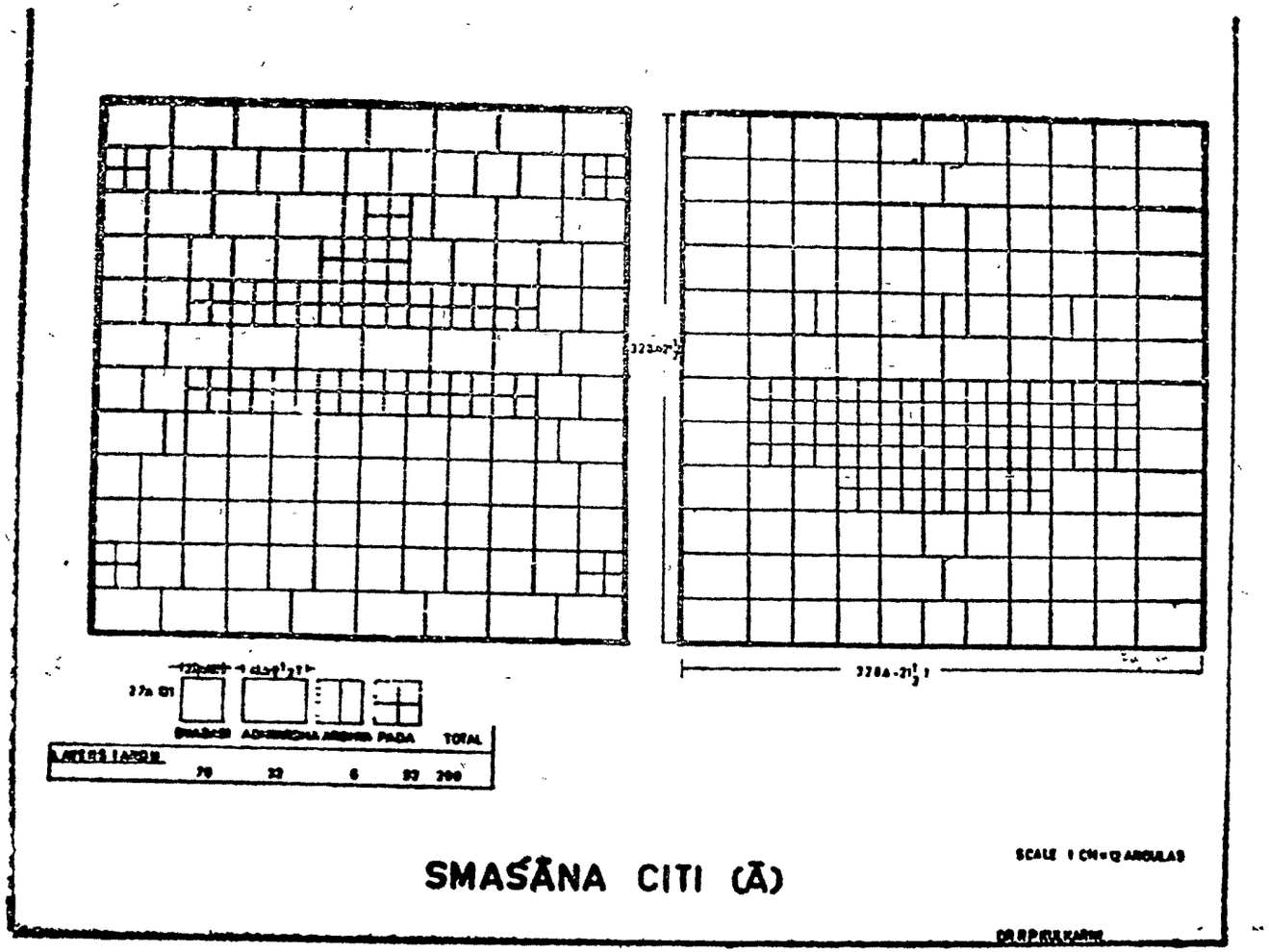


Fig 74 Smaśāna Citi

Indological Truths

Construction of fire-altars in the form of a TORTOISE[147]

Fire-altars in the form of a tortoise are of two types (i) Tortoise with twisted limbs (vakrangaḥ) (ii) the tortoise with rounded limbs (parimaṇḍalāḥ, Baudhāyana) has given about the construction of fire-altar in the form of a TORTOISE

According to tradition, a fire-altar in the form of tortoise is to be construction by one desiring to win the world of the supreme spirit The fire-altar is measured out as follows

The body is a square of side equal to 10 prakramas (300 angulas) Its corners are cut off with 2 prakramas on each side 4 squares each of side equal to 1 prakrama are made in (the middle of) the eastern front and 2 of them lying at either extreme are cut off by their diagonals The same is done on the southern, western and northern frond This is the body The head is 5 padas (75 angulas) long by $^1/_2$ purusa (60 angulas) broad, of which the two eastern corners are to be cut off with 1 prakrama (30 angulas) on each side

The feet are to be raised where the corners (of body) have been cut off The foot (in the south-eastern corner) is 22 padas (30s angulas) broad by twice that measure (i.e 60 2angulas) long and its eastern corner is cut off by 2 2padas Thereby is explained the cutting off of the other (three) feet Off the two feet at the western (corners of the body), their western corners are to be cut off Thus addition of (two) aratnis and (one) pradeśa, the seven fold (fire-altar of $7^1/_2$ sq pur) is accomplished, square bricks of side equal to one-fourth of purusa and their halve and quarters (obtained by dividing the first type diagonally) are to be made for this Adhyardhā quarter bricks bounded by four sides measuring 1 prakrama, 1 pada, 1 pada and 2 pada Two of them touching each other along their long sides (1 prakrama) are made into another (type of) brick (haṃsamukhi) Another type of square brick of side equal to half of 2 2 pada (i e pada or 15 2 angulas) The construction may be shown in figure - 69, as follows

147 BŚS 9 1-33

Indological Truths

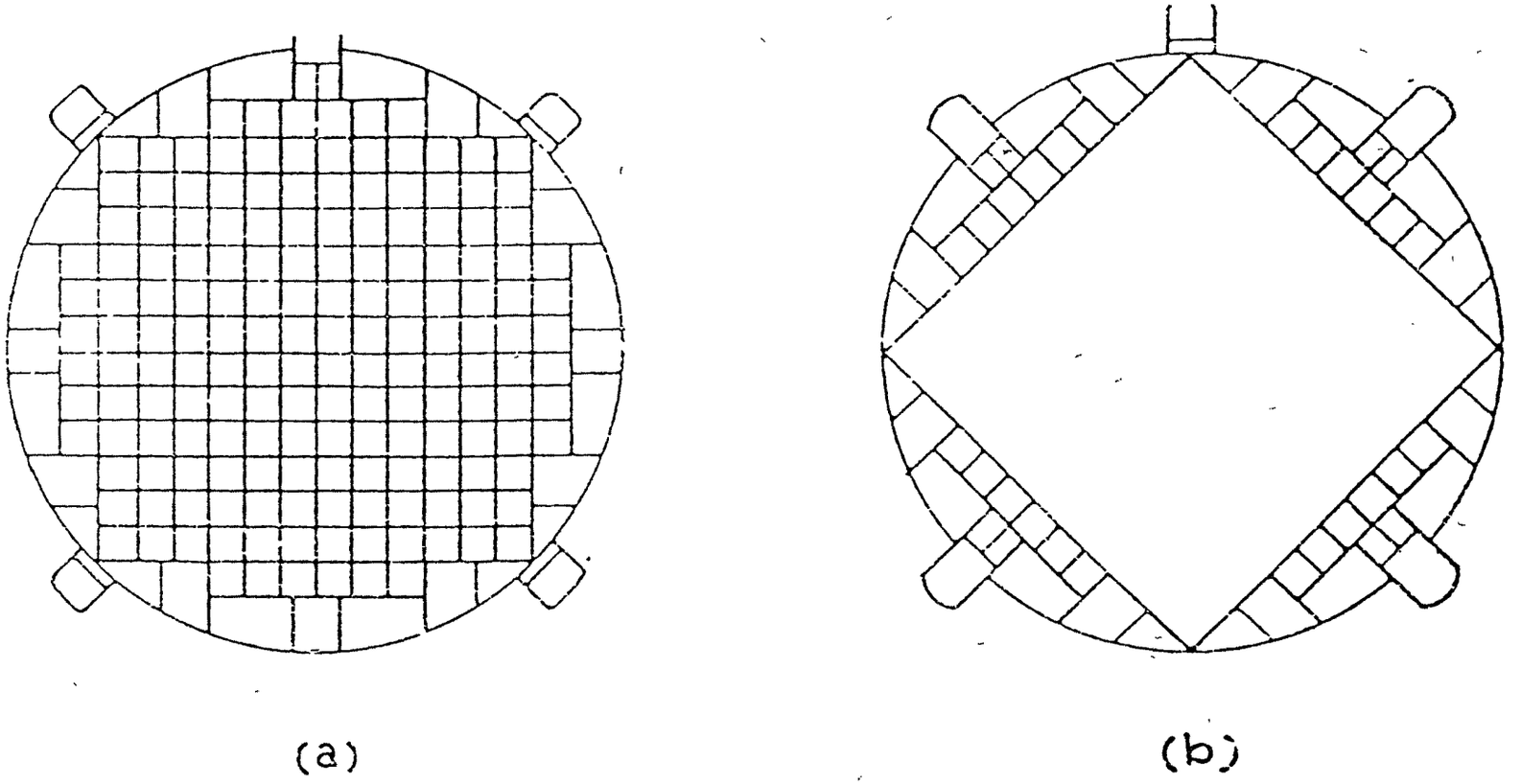


Fig. 7a. Arrangement of bricks in the circular *kūrmacit*,—
(a) 1st layer ; (b) 2nd layer.

Indological Truths

The area of the citi should be $7^1/_2$ sq purusas (108000 sq ang)

Area of the ātman=300x300=4x60x60x$^1/_2$+4x120x30-4x30=90,000-7200+14400-3600=93600 sq ang

Area of the head=75x60-30x30=3600 sq ang

Area of feet=(2 [illegible]800x [illegible]800-$^1/_2$800x [illegible]00)x4=10800 sq ang

Total area = 93600+3600+10800=108000 sq ang

Sizes of Bricks

First prepared square bricks of 30 angulas sides

Bricks The following 6 types of bricks have been prescribed for covering the fire-altar-

B_1 - square brick of side $^1/_4$ pu caturthi 30x30 sq ang

B2 - triangular brick (diagonally cut), half of caturthi, ardhā, two sides 30 ang each, diagonal side 30 2 ang

B_3 - triangular brick, one fourth of caturthi, pādyā, two sides 152 ang each, the diagonal side 30 ang

B_4 - four sided brick of area $1^1/_2$ pādyā, its sides are 15 ang , 15 ang , 30 ang and 15 2 ang

B_5 - brick formed by joining 2 B4 bricks along the longest side, haṃsamukhi

B_6 - square brick of area equal to half caturthi, 15 2x15 2 sq ang

Placement of bricks in the first layer[148]:

In the placement (of bricks), a square brick (of side equal to 15 2 angulas) is to be placed at the top of the head, followed by two hamsamukhi (bricks) below it 5 square bricks and 2 quarter bricks (pañcami - pādyā) are to be placed in each foot Half bricks are to be placed wherever a corner has been cut off The rest of the

148 BŚS 9-22-32

Indological Truths

fire-altars is to be covered with caturthi bricks The number of (of 200 bricks) is to be completed with half bricks

Arrangement of bricks can be given in the table

Parts of the Citi	Brick type						Total
	B_1	B_2	B_3	B_4	B_5	B_6	
Head	2	–	2	–	2	–	6
Body	42	124	–	–	–	–	166
Feet	–	–	8	–	–	20	28
	44	124	10	–	2	20	200

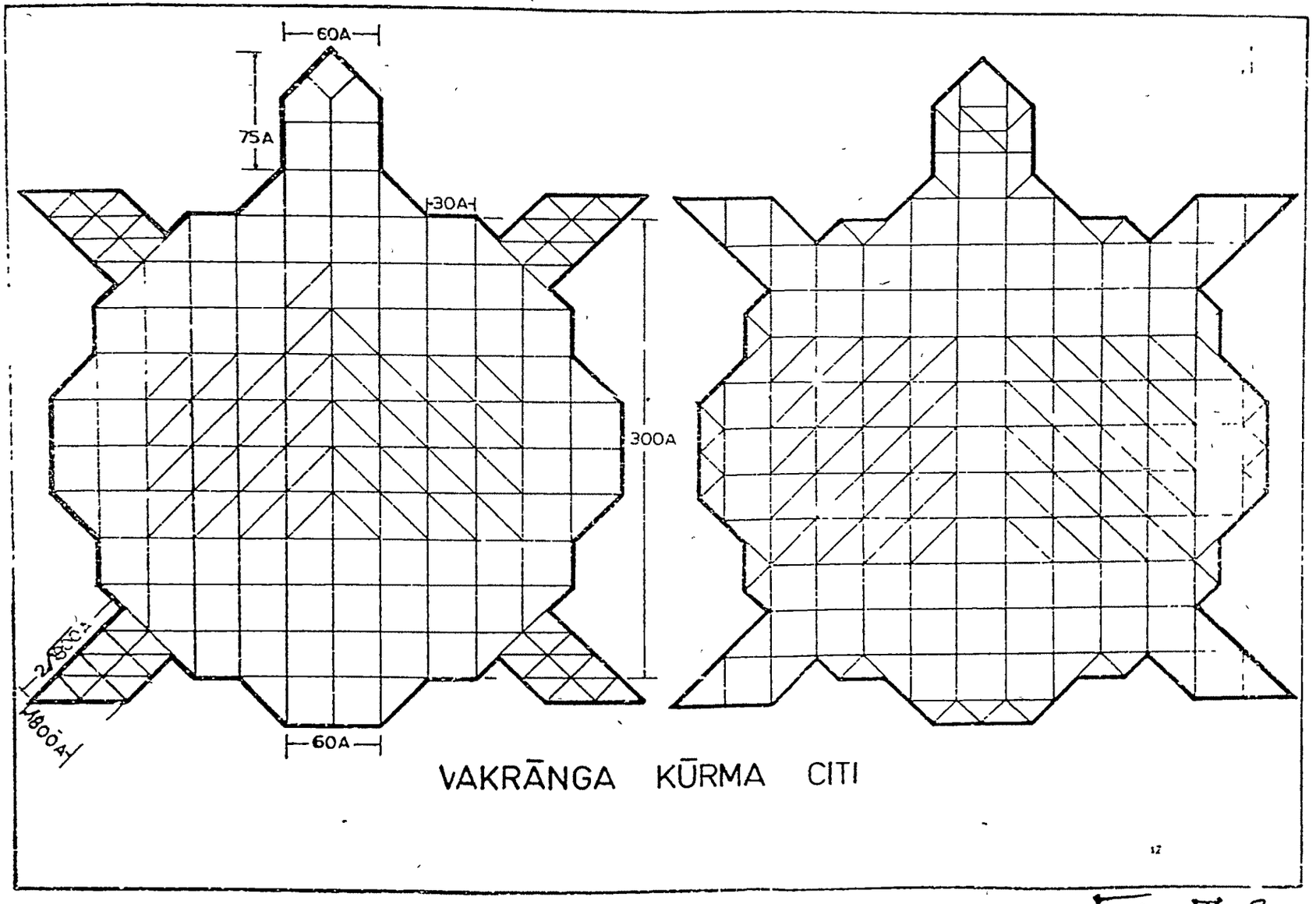
Placement of bricks in the second layer:

In the second layer the placement of bricks is as follows

1 haṃsamukhi at the top of the head and 1 quarter brick on either side of it are to be placed To the west of these on each side (of the head) 2 (four sided) adhyardhā quarter bricks oppositely oriented are to be placed To the west of these on both sides are to be placed 2 quarter (caturthi-pādyā) bricks in alignment with intersection 2 caturthi (here called dvipadas or squares of side equal to 2 padas or 30 angulas) and 3 half bricks are to be placed in each foot Half bricks and quarter bricks are to be placed wherever a corner has been cut off The rest of the fire-altar is to be covered with caturthi bricks The number (of 200 bricks) is to bc completed with half bricks This can be shown in a table as follows

Parts of the Citi	Brick type						Total
	B_1	B_2	B_3	B_4	B_5	B_6	
Head including parts of body	1	2	4	4	1	–	12
Body exlcuding portions	49	88	31	–	–	–	168
Accounted for in head and feet, includng parts of body	8	12	–	–	–	–	20
Total	58	102	35	4	1	–	200

Indological Truths



VAKRĀNGA KŪRMA CITI

Fig 73

Indological Truths

The construction of a fire-altar in the form a tortoise second type with rounded limbs:[149]

Here the method of construction is the same as that already described in the case of the circular trough (B Ś S 18) We have seen that 120 sodaśi bricks equal $7^1/_2$ sq pu 5 soḍaśi briçks are taken out and the area of the remaining 115 sodaśis (103500 sq ang) is turned into a square of side 321 ang 24 ti This square is transformed into circle of the same area as per B Ś S 2 9 In this act of circling the square, each of 5 sodaśi bricks is cut by the circle and the western portion transferred to the eastern side will be essential besides those noted before

Conclusion :

In all the above mentioned citis I would like to notify some important observations from both geometrical point of view and technical point of view

Knowledge of geometry

(i) To construct a square of required size and it may be divided into rectangle, or triangle, or right angled triangle, or isosceles triangle, scalene triangle, etc

(ii) To construct a trapezium of big size and having very large area or a square equal to a simple multiple or (submultiple) of another square

(iii) Constructing a square equal to the sum or difference of unequal squares Transforming a rectangle into a square and vice versa

(iv) The problem of the division of figures into particular number of parts of specified shapes

(v) Constructing similar figures by keeping the over all geometrical characteristics same

149 BŚS 10 1 12

Indological Truths

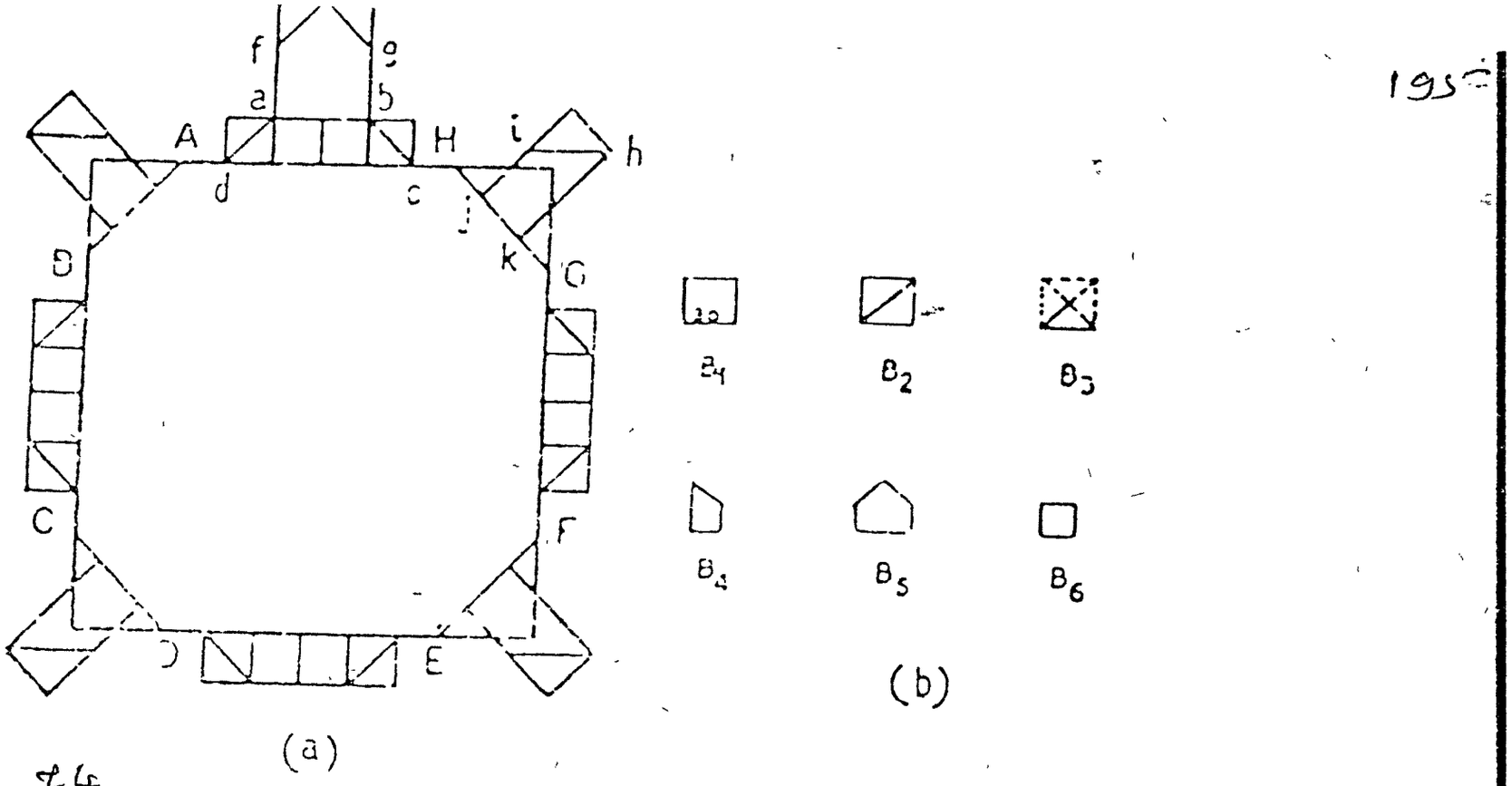


Fig. 74 Fire-altar in the form of a tortoise with twisted limbs.
(a) Lay-out. (b) Brick types.

Indological Truths

Technical knowledge

(i) Layout of more complex nature of architectural designs in shape of birds (śyena, kanka, alaja) or an animal (tortoise)

(ii) Laying of bricks in different layers in a symmetric way

(iii) Naming the different bricks according to their sizes as pādya, ardhapādya, Janghāmātri, Adhyardhā, Padabāgh, Trigrāhini, 'Brhatī, Ardhapādabhāga etc (This type of naming is not found now for the different types of bricks in any type of construction)

(iv) Layout of kāmya citis involves an art of science and technology is applied in measurement, design and in finishing the structure

Method of increasing the area of a citi:

As I already said, the area of all the Kāmyacitis which I mentioned before, is $7^1/_2$ sq purusa (108000) But if the same citi is constructed for the repeat performance of the same sacrifice, shall be increased by one sq purusa area, i e $8^1/_2$ sq purusas The area of this citi is increased by additional one sq purusa are for each subsequent sacrifice The maximum area of the citi could be $10^1/_2$ sq purusas The geometrical constructions to increase the area of one sq purusa as suggested by Brāhmana and different Śulbasūtras are explained below

(i) Increase of area in Śatapatha Brāhmana

Śatapatha Brāhmana[150] itself suggested a method to obtain a citi of the area equal to $10^1/_2$ sq purusas

The length of the side of a square of the area of 14 sq prakramas is 112 3 ang The length of the side of a square of the area equal to $7^1/_2$ sq purusas is 10 95 prakramas (1 prakrama=30 ang) The area of the square with the length of sides=10 95 prakramas best one prakrama=11.3 ang. will be

150 सा यावत्येषा सप्तविधस्य वेदिस्तावती चतुर्दश कृत्वऽएकशतविधस्य वेदिं विमिमीते ॥ Ś Br 10 2 3 7

Indological Truths

$$\frac{10\ 95x10\ 95x112\ 3x11\ 3}{120x120} = 102\ 6 \text{ sq puruṣas}$$

The error is of 1 1 sq purusas only

Śatapatha Brāhmana[151] gives details of the area of the citi of $101\frac{1}{2}$ sq purusas as given below

Area of Ātman=56+12/7 x 56 sq purusas

Area of two wings=14+14+$\frac{3}{7}$ x 14+$\frac{3}{7}$ x 14+$\frac{1}{5}$ x $\frac{1}{7}$ x 3 ¼ sq purusas

Area of tail=14+$\frac{3}{7}$ x 14+$\frac{1}{10}$ x $\frac{1}{7}$ x 3+ ¼ sq pu

Total area of the Citi=56+12 828+28+3 207+0 320+14+1 603+0 160=116 1185 sq purusas

The area obtained is larger by 14 6 sq purusas In Ś Brā it is mentioned that the area obtained by 13 0 sq purusas

(ii) Method suggested by BŚS:[152]

BŚS states that given square is divided into 15 rectangles by dividing two sides of the square into 15 equal parts, and the area of two rectangles is to be added in the given square which will increase its area by one sq purusa

The area of the square is $7\frac{1}{2}$ sq purusas The length of the side is $15/2$ purusas The opposite sides of the square are divided into 15 parts 15 number of rectangles with length equal to $15/2$ purusas and width equal to $\frac{1}{15}x15/2$ purusas are obtained Area of these rectangles is $2x\ 15/2=1$ sq purusa

The application of this rule for caturasra Śyena citi is explained below

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151 अथाग्नेविधाः १ अष्टविंशति प्राञ्चः पुरुषाऽअष्टाविंशतिस्तिर्यञ्चः सऽआत्मा चतुर्दश पुरुषा दक्षिणः पक्षश्चतुर्दशोत्तरश्चतुर्दश पुच्छ चतुर्दशारत्नीन्दक्षिणे पक्षऽउपदधाति चतुर्दशोत्तरे चतुर्दश वितस्तीः पुच्छऽइति त्वष्टानवतेः पुरुषाणा मात्रा सादिमानानाम् ॥ अथ त्रिपुरुषाः रज्जु मिमीते । ताः सप्तधा समस्यति तस्यै चतुरो भागान् आत्मन्नुपदधाति त्रीन्पक्षपुच्छेषु ॥ अथारत्निमात्री मिमीते । ताः सप्तधा समस्यति तस्यै त्रीन्भागान् दक्षिणे पक्षऽउपदधाति त्रीनेवोत्तरे निःसृजति चतुरः ॥ अथ वितस्तिमात्री मिमीते । ताः सप्तधा समस्यति तस्यै त्रीन्भागान्पुच्छऽउपदधाति निःसृजति चतुरःएवमेषः एकशतविधः एतया वेद्या सम्पद्यते ॥ Ś Br 10 2 3 14 तदाहुः । यत्त्रयोदशपुरुषाऽअतियन्ति ॥ Ś Br 10 2 3 15

152 BŚS 2-12

Indological Truths

Area of the ātman=4 sq purusas

Area of the two wings=$2x1^1/_5=12/_5$ sq purusas

Area of the tail=$1^1/_{10}=11/_{10}$ sq purusas

Total area=$7^1/_2$ sq purusas

Each square and rectangles are divided into 15 rectangles and areas of respective two rectangles of caturasra Śyena citi are added so as to get the citi of the area equal to $8^1/_2$ sq purusas

Area of ātman, two wings and the tail of the citi of $7^1/_2$ sq purusas are $4+12/_5+11/_{10}$ sq purusas To obtain the area of ātman, two wings and the tail of the citi of $8^1/_2$ sq purusas, $2/_{15}$ of the respective areas are added, i e

$2/_{15}$ $(4+12/_5+11/_{10})=8/_{15}+24/_{75}+22/_{150}$ sq purusas

Area of the ātman=$4+8/_{15}=68/_{15}$ sq purusas

Area of the wings=$12/_5+24/_{75}=204/_{75}$ sq purusas

Area of the tail=$11/_{10}+22/_{150}=187/_{150}$ sq purusas

Total area=$1275/_{150}=8^1/_2$ sq purusas

For obtaining the citi of area equal to $9^1/_2$ sq purusas add the respective increases, in areas in the areas of ātman, wings and the tail of total area of $8^1/_2$ sq purusas

Area of the ātman=$68/_{15}+8/_{15}=76/_{15}$ sq purusas

Area of the wings=$204/_{75}+24/_{75}=228/_{75}$ sq purusas

Area of the tail=$187/_{150}+22/_{150}=209/_{150}$ sq purusas

Total area=$760/_{150}+456/_{150}+209/_{150}$ sq purusas

$=1425/_{150}=9^1/_2$ sq purusas

(iii) Increase of area of citi according to M.Ś.S.:[153]

It is shown above that the area of square of $7^1/_2$ sq purusas when multipled by

153 MŚS 10 3 3 6

Indological Truths

$2/_{15}$ gives the increase in its area equal to one ang purusa and when added together the total area is equal to $8^1/_2$ sq purusas Now $2/_{15}$(=0 1334) ang purusa is equal to 1920 sq angulas According to M Ś S this multiplying factor is equal to 0 1225 sq pu The increase in the area is therefore, somewhat less than one sq purusa as shown below

0 1225 (4+12/5+11/10)=0 49+0 294+0 13475 sq purusas

Area of the ātman=4+0 49=4 49 sq purusas

Area of the wings=12/5+0 294=2 694 sq purusas

Area of the tail=11/10+0 13475=1 234 sq purusas

Total area=8 41875 pu

Thus the error is of 0 08125 sq purusas This error will, of course, go on increasing with subsequent successive enlargements of the area of the citi

(iv) Method suggested by Kātyāyana:[154]

Kātyāyana suggested five methods in increasing the area of citi

1 Draw a square of one sq puruṣa area Draw the square of $7^1/_2$ sq purusas area Draw a square of area of $8^1/_2$ sq purusas by the method of summing the area of two squares of unequal areas In order to increase the area of $7^1/_2$ sq purusas to $9^1/_2$ sq purusas draw a square of one sq purusa area Draw a square of the sides of the length equal to that of the hypotenuse of this square The area of this square is two sq purusas A square of $9^1/_2$ sq purusas could be drawn by the method of addition of areas of two squares of different areas, i e one of $7^1/_2$ sq purusas and another of two sq purusas Thus a square of $9^1/_2$ sq purusas area is obtained Follow the procedure so as to obtain the square of three sq purusas area and the above procedure

(ii) Say a square of $8^1/_2$ sq purusas area is to be obtained [155] The length of its sides is 349 8571 ang The length of the side of a square of $7^1/_2$ sq purusas area is

154 KŚS 5 2 3

155 KŚS 5 4 2

Indological Truths

8 6335 sq ang In order that 349 8571 ang is equal to 2 7386 purusas the measure of purusa is 127 75 angulas Draw a citi, say a caturasra śyena citi of the area equal to $8^1/_2$ sq purusas assuming that one purusa is equal to 127 75 ang The procedure of changing the unit of purusa into ang is to be followed so as to obtain the citis of $9^1/_2$ and $10^1/_2$ sq purusas etc

In case of Caturasra Śy Citi

In the length of the side of the ātman=2 purusas=2x127 75 angulas

The length of the wing=1 2 purusa=1 2x127 75 ang

The width of the wing=1 0 purusā=1 0x127 75 ang

The length the tail=1 1 purusa=1 1x127 75 ang

The width of the tail=1 purusa=1 0x127 75 ang

The area of the ātman=$\frac{2x127\ 75x2\ 127\ 75}{120x120}$ = 4 533 sq puruṣas

The area of two wings=$\frac{2(1\ 2x127\ 75x1x127\ 75)}{120x120}$ = 2 72 sq puruṣas

The area of the tail=$\frac{1\ 1x127\ 75x1\ 0x127\ 75}{120x120}$ = 1 246sq puruṣas

The total area=8.5 sq purusas

(iii) Divide[156] the given square into 25 equal squares Draw a square of area of equal to the sum of the areas of five such squares Divide this square into nine equal squares Subtract the area of these three squares from the area of the second square The remaining area is to be added into the first square so as to obtain an increase in the area of the original square by one sq purusa

(iv) The square[157] of the given area is divided into 49 squares of equal area Find the sum of the areas of seven such squares and subtract from it the area of the rectangle of which one side is equal to that of the square and another side is $1^1/_7$

156 KŚS 5 4

157 KŚS 5 10

Indological Truths

angulas The remainder when added to the area of the original square increases its area by one sq purusa

The area of $7^1/_2$ sq purusa is divided into 49 squares of equal area The area of such seven squares is $^7/_{49}x7^1/_2$ sq purusas The length of the side of the square of $7^1/_2$ sq purusas area is 2 738 purusas The area of the rectangle is $2\ 738x120x^8/_7$= 375 58 sq angulas which is equal to 0 0261 sq purusas

The area to be added to the original square=$^7/_{49}$ x$15/_2$-0 026=1 045 sq purusas

The error is thus of 0 045 sq purusas

(v) The length[158] of the side of a square of the area of $14^3/_7$ sq prakramas is to be taken as prakrama measure for the citi of $101^1/_2$ sq purusas The length of the side of a square of area of $14^3/_7$ sq prakramas is 114 ang The area of the first fire-altar is $7^1/_2$ sq purusas The length of the side of the square is 328 6 ang i e 10 95 prakramas (1 prakrama=30 ang)

The area of the square, the length of the side of which is also 10 95 prakramas but each prakrama is of 114 ang will be

$$\frac{10\ 95x10\ 95x114x114}{120x120} = 108\ 25 \text{ sq puruṣa}$$

A square of the area $10^1/_2$ sq purusa is required whereas the once obtained is of $108^1/_4$ sq purusa area The error is of $6^3/_4$ sq purusas

Thus Śulbasūtrakāras not only knew the method of constructing a citi of $7^1/_2$ sq. purusas in various forms but also knew how to increase the maximum area of citi upto $101^1/_2$ sq purusas

□

158 KŚS 6-2

Indological Truths

Chapter - 6

Pythagoras theorem and Bhuja-koṭi-karṇa nyāya

: A Critical Analysis

"The square on the hypotenuse of a right angled triangle is equal to the sum of the squares on the other two sides " This theorem is generally called the Pythagoras theorem He was Greek philosopher-mathematician and he belongs to 540 B C [1] The question of Greek origin of the theorem and also whether Pythagoras himself was the dicsovere of it and of its proof has not been solved yet The tradition attributing the theorem to Pythagoras is due to Cicero (B C 50), Diagenes Laertius (second century A.D) Athenaeus (circa 300 A D) Heron (3rd century A D) and Proclus (circa A.D. 460) and therefore started five centuries after the death of Pythagoras, Jange pointed out that the Greek literature of the first five centuries after Pythagoras contained no mention of the discovery of this or any other important geometrical theorem by the great philosopher and further emphasized uncertainities in the statement of Pintarch and Proclus Although various attempts have been made to justify the tradition and trace the proof to Pythagoras, no record of proof has come down to us earlier than that given by Euclid [2]

As it is well known, mathematics, including geometry in ancient India did not follow the Euclidean tradition, and usually gave the rules, leaving their proofs to be explained by the teachers to the pupils of their respective schools, several scholars who discussed the issue of proof have shown that such proof is impilicit in the very operations with rectilinear figures

As to the relation $4^2+3^2=5^2$ from which the theorem of rational triangle is

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1 He was a pupil of Thales He proved a well known and tremendously useful theorem credited after his name The theorem of Pythagoras

2 Heath T L (1956), 'The Thirteen Books of Euclid's Elements' - 3, Vol 1, P 352

Indological Truths

4 The area of the square formed by joining the middle points of the sides of a rectangle is a rhombus whose area is half that of a rectance [7]

5 A quadrilateral formed by the lines joining the middle points of the sides of a rectangle is a rhombus whose area is half that of the rectangle [8]

6 A parallelogram and rectangle on the same base and within the same parallels have the same area [9]

7 The square on the hypotenuse of a right angled triangle is equal to the sum of the squares on the other two sides [10]

8 If the sum of the squares on the two sides of a triangle be equal to the squares on the third side, then the triangle is right angled [11]

The theorem given above is generally called the Pythagorous theorem But this is one very imporant proposition which together with its converse (i e theorems) looms much more considerably than, anything else through the entire geometry of the Śulba Because all three Śulbasūtrakāras stated this theorem in almost same manner as follows

दीर्घचतुरस्रस्याक्ष्णयारज्जुः पार्श्वमानी तिर्यङ्मानौ च यत्पृथग्भूते कुरुतस्तदुभयं करोति ॥
BŚS 1 48

दीर्घस्वाऽक्ष्णयारज्जुः पार्श्वमानौ तिर्यङ्मानौ च यत् पृथग्भूते कुरुतस्तदुभयं करोति ॥
ĀŚS 1 4

दीर्घचतुरस्रस्याक्ष्णया रज्जुस्तिर्यङ्मानौ पार्श्वमानौ च यत् पृथग्भूते कुरुतस्तदुभयं करोतीति क्षेत्रज्ञानम् ॥
KŚS 2 11

It should be noted that in Śulbasūtra the actual enunciation of the theorem is

---

7 BŚS 1, 50

8 ĀpŚS 5 6

9 BŚS 1 51, ĀpŚS III 5

10 BŚS 1.48, ĀpŚS 1 4, KŚS II-11

11 BŚS 1 45, ĀŚS 1 5, KŚS II 12

Indological Truths

the area of that square The oldest known Śulbakāra, Bodhāyana states the second proposition before the first intervened by two other rules in the same connection The posterior writers like Āpastamba and Kātyāyana place the second just after the first It shows that by the time of Āpastamba and Kātyāyana the importance and generality of the theorem of the square of the diagonal of rectangle was recognised fully So they very naturally stated the corresponding theorem for the particular case of a square as a corollory to it

Another proposition which has been most freely used in the Śulba for the construction of a right angle is this

"If a triangle is such that the square on one side of it is equal to the sum of the squares on the other sides, then the angle contained by these two sides is a right angle " The correct proposition is not found explicitly defined by any Śulbakāra but its truth is tacitly assumed by all of them

Did the ancient Śulbasūtrakāras discover a proof of the theorem of the square of the diagonal? No Conclusively satisfactory answer which will be beyond a shadow of doubt can be given to this question. For, there is not found any mention direct or indirect, of such a proof, even if it had existed anywhere in the early literature of the Hindus

Proposed derivation of theorem of the square of the diagonal as supposed to be probably given by Śulbasūtrakāras as suggested by different research workers are given below

a) Būrk (1901)[16] :

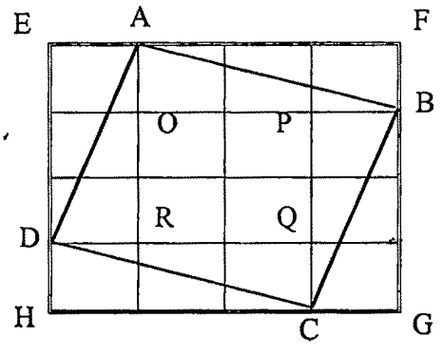
(i) The proof of the theorem was discovered in the figure of Caturasra Śyena cit

HBGK is the square of 4 sq purusa area representing the body of the śyena citi ABCD is the square of one sq purusa area The body of the śyenaciti is formed by four such squares

16 Burk, A "Das Āpastamba Śulvasuutra", L V ISOIPP 543-591, LVI, 1962, Pp 327-291

Indological Truths

(e) Datta (1932)[19]: had given a general proof of this theorem based on the construction of Daśapadottara vedi



K Ś S (23-9) "The square ABCD is equal to ten elementary squares four forming the inner squares OPQR and the remaining six form the halves of the four rectangles surrounding it viz AFBO, BGCP, CHDQ and DEAR, each of which contains three elementary squares These can again be divided into two groups, one group consisting of one elementary squares forming the square on the line OB and another group of a single elementary square on the side OA Thus it is proved that $AB^2=OA^2+OB^2$

The above given proof of theorem of the square of the diagonal are having one defect and that is they assume a particular construction to prove the theorem whereas that construction might have been based on that theorem

Rational Right angle triangles:

A triangle with the angle of one side is 90° is called as right angle triangle The passage in Ś Br. is as follows.[20]

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19 Hindu contribution to Mathematics- B B Datta, University of Allahabad, 1 to 11, Pp 1479-512

20 तद्य एव पूर्वार्ध्यो वर्षिष्ठः स्थूणाराजो भवति । तस्मात् प्राङ्प्रकामति त्रीन् विक्रातच्छङ्कु निहन्ति सोऽन्तःश्चातः, III 5 1 1

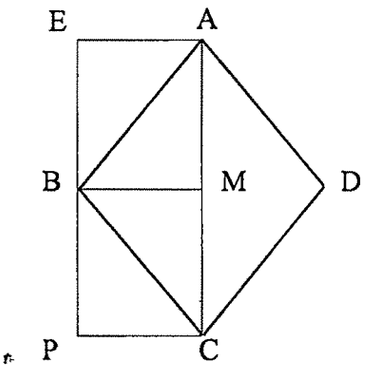
तस्मान्मध्यमाच्छङ्कोः । दक्षिणा पञ्चदश विक्रमात् प्रकामति तच्छङ्कुं निहन्ति सा दक्षिणा श्रोणिः । प्राङ् षट्त्रिंशत विक्रमान् प्रक्रामति तच्छङ्कु निहन्ति सपूर्वार्धः । तस्मान्मध्यच्छङ्कोः । दक्षिणा द्वादश विक्रमान् प्रक्रामति तच्छङ्कुं निहन्ति स दक्षिणोऽसः । IX, 5 16

Indological Truths

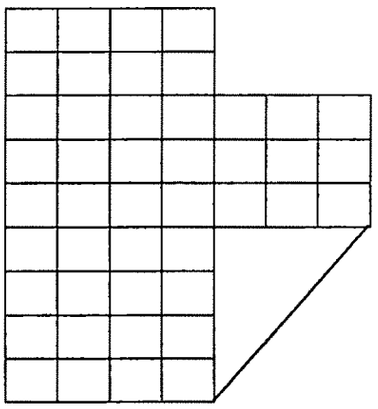
Square ABCD=rectangle AEFC

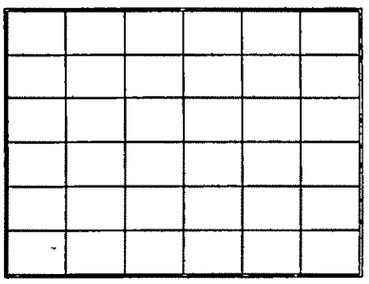
Square ABCD on CD=Square EAMB on AM

+Square BMCF on MC



(iii) Bodhāyana (B.Ś.S. 5-10-6)





ABC is a triangle with sides AB=3, AC=4 and BC=5

Square ABDE=9 unit squares

Square AFGC=16 unit square

Square ABCD is drawn separately Two rectangles AHJC and BCKL are drawn, such that they constitute 16 unit squares

The square DHJK is formed of 25 unit squares Thus the area of square based on BC=area of square based on AB+area of square based on AC

(b) **Cantor:**

ABC is a rational right angle triangle such that AB=AC

Square CDE is based on BC

Square ABJH is based on AB and square ACFG is based on AC Join JA and

Indological Truths

This description is in connection with the Mahāvedī This also appears in Kāṭhaka Samhita[22], Maitrāyanī Samhitā[23], Kapiṣṭhala Saṃhitā[24] and Śatapatha Brāhmana[25] The passage in Ś Br is as follows

"From the (Western) end of the Vedi he measures off the Vedi 36 steps long eastward, thirty (steps) broad behind, and 24 (steps broad) in front-that makes nenety This then is the Vedi measuring ninety steps, thereon he lays out the sevenfold fire altar"

The right angle triangle in this case is of half of the thirty steps (from the Western cross line) i e 15 steps (perpendicular) thirtysix steps base eastward, and the total sum of the three sides is 90, which means that hypotenuse is of 30 steps as-

$15+36+39=90$ also $15^2+36^2=39^2$

(Also according to Āpte (1936) the sum of the sides and prācī of the Vedi is 90 i e. 30+24+36=90)

Dr Burk stated that at the time of Taittirīya Saṃhitā they knew the theorem of the hypotenuse at least as regards the numbers 3,4, 12,15, 15,8, 7,24, 12,36 and 15,36 [26]

2 Rational right angle triangle with sides of different length as quoted in different Śulbasūtras are given in table 1 (in the following page)

The methods by which possibly the Śulbasūtrakāras might have obtained different rational right angle triangles as given by different research workers are given below:

---

22 Kāt Saṃ xxv 4

23 Mait Saṃ iii 8 4

24 Kap Saṃ 38 6

25 Śat Br III 5 1 1, X, 2 3 4

26 Āpte, 1936

Indological Truths

This construction Burk had extended for group 3 As such it is not necessary Śulbasūtras may be knowing that multiplying the three sides of a right angled triangle by a whole number will give another right angled triangle 15, 36 and 39 are obtained by multiplying 5, 12 and 13 each by three (see Āpastamba 6 17, 60, 156 These figures are obtained by multiplying 5, 12 and 13 by 12 and many other examples could be found)

b) Muller (1930) :

Muller based his method of obtaining the sides of a right angled triangle from Āpastamba[28]

From adjoining figure

$1^2=1^2$.

$2^2=1^2+2,1+1^2$

$3^2=2^2+2\ 1+2\ 1+1^2=2^2+2\ 2+1^2$

$4^2=3^2+2\ 3+1^2$, i e $(X+1)^2=X^2+2X+1$

$13^2=12^2+2\ 12+1^2=12^2+25=12^2+5^2$ Group 1

$(n+2)^2=n^2+4n+4$ (from adjoining fig)

$(15+2)^2=15^2+15x4+4=15^2+64=15^2+8^2$

$17^2=15^2+8^2$. Group 2

c) Datta (1932) :

Dutta had followed Burk (1901) and Muller (1930) and found generalised equations to determine the sides of a right angled triangle He, however, gave Kātyāyana's construction of obtaining a square of area equal to the sum of any number of squares, all of equal area[29], as the basis of his method

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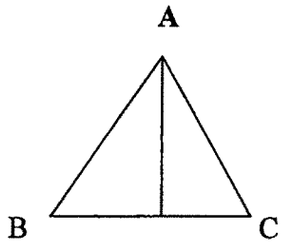
28 Āp 3 9-12

29 KŚS 6 7

Indological Truths

c) Datta B B (1932) had followed Burk (1901) and Muller (1930) and found generalised equations to determine the sides of a Right angle Triangle He, however, gave Kātyāyana's construction of obtaining a square of area equal to the sum of any number of squares, all of equal area (K Ś S 0 7) as the basis of his method.



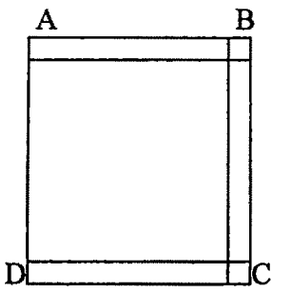
n = number of squares each of area a

$BC = (n-1)\,a$; $AB = AC = \left(\frac{n+1}{2}\right) a$

$$AD^2 = \left[\frac{(n+1)\,a}{2}\right]^2 - \left[\frac{(n-1)\,a}{2}\right]^2 = n.a^2.$$

Putting $n = m^2$.

$$m^2a^2 + \left(\frac{m^2-1}{2}\right)^2 a^2 = \left(\frac{m^2+1}{2}\right)^2 a^2.$$



Area of square ABCD = n^2

A square can be obtained by putting two rectangles 2n and One square 1 around the square ABCD

Let us assume $2n+1=m^2$

$\therefore n = \frac{1}{2}(m^2-1)$ $\quad \therefore n+1 = \frac{1}{2}(m^2+1)$

$$\text{Then } m^2 + \left(\frac{m^2-1}{2}\right)^2 = \left(\frac{m^2+1}{2}\right)^2$$

Indological Truths

B B Datta (1932) assumed that the above given algebra was known to Śulbasūtrakāras as he states that "Proclus (450 A D) has attributed the formula (A) to Pythagoras (540 B C) and formula (B) to Plato (375 B C)"

d) If algebra as much as given above by Dutta (1932) was kown to Śulbasūtrakāras, coul one assume that they knew the equation $x^2\bar{1}^2=(x+y)(x-y)$ This equation can be proved by reversing the method given above by Burk (1901)

$x^2=y^2+2y(x-y)+(x-y)^2$

$x^2-y^2=(x-y)(2y+x-y) = (x-y)(x+y)$

The following procedure to find the right angled triangle is based on the knowledge of the above formula

According to Pythagoras theorem,

$x^2=x^2+y^2$

$x^2=z^2-y^2=(z+y)(z-y)$.

Let us assume that the length of x is 15 angula Fractioning the figure 15 in its original factors

$15^2=(z+y)(z-y)$ 3x5x3x5=(z+y) (z-y)

(3x3) (5x5)=(z+y) (z-y)

z+y=25, z-y=9 2z=34 z=17 and y=8

∴ a right angled triangle with sides 15, 8 and 17 is obtained

This procedure is explained below by an additional example

In above triangle, let x=36

$36^2=(z-y)(x+y)=36x36$

=2x2x3x3x2x2x3x3

=16x81

Indological Truths

The construction would be

Draw a circle of the diameter equal to the prācī of the Vedi (say 188 angula) Draw diameter AB Draw a line AC of length equal to one half the length of the eastern side (i e 52 angula) Measure the length CB (which will be 194 angula) The length of the cord for laying out this triangle will be AC+CB

$\Delta ACB=90°$

Application of Rational Right angle triangle.

Śulbasūtra quoted rational right angle triangles with sides of different lengths Bodhāyana says- " the areas (of the squares) produced separately by the length and the breadth of a rectangle together equal the area (of the square) produced by the diagonal This is observed in rectangles having sides 3 and 4, 12 and 5, 15 and 8, 7 and 24, 12 and 35, 15 and 36 " By considering these value we may conclude that-

$3^2+4^2=5^2$ (BSS 1 13, MŚS 1 11)

$12^2+5^2=13^2$ – Do – (ĀŚS 5 4)

$15^2+8^2=17^2$ – Do – (ĀŚS 5 5)

$7^2+24^2=25^2$* – Do –

$12^2+35^2=37^2$ – Do –

$15^2+36^2=39^2$ (ĀŚS 5 4)

$6^2+2^1/_{22}=(6^1/_2)^2$ ĀŚS 6 6, MŚS 2 4

$96^2+40^2=104^2$ MŚS 1 4-1 6

$12^2+9^2=15^2$ KŚS 2 5

All these are considered as 'triplet numbers' in mathematics

Problem from modern methametics:

If we consider the problem in 10th standard Mathematics text book, the same problem is repeated, i e in the sides of a triangle are, 7, 24 and 25 are the values of the three sides, prove that the triangle is right angled triangle [31]

31 Mathematics (10th Standard Text Book, P 213 , Directorate of Text Books, Bangalore, 2006

Indological Truths

Let ΔABC be a right angle triangle

AB=7 BC=24 AC=25

According to B Ś S $AC^2=BC^2+AB^2$

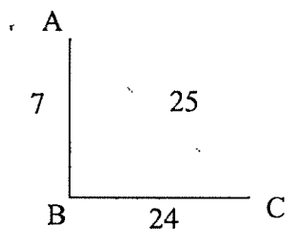
If this rule holds good, then it is right angled triangle

$25^2=7^2+24^2$

$7^2=49$ $24^2=576$

49+576=625

$25^2=625=625$



It is right angled triangle

Conclusion :

Thus the sides of a right angled triangle have a special relationship among them This relationship is widely used in many branches of mathematics, such as mensuration and trignometry

□

Indological Truths

Chapter 7

Value of $\sqrt{2}$ and π- with Modern Scientists proof.

The rational root of an irrational number is called Surd in Mathematics $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, etc are named as 'Surds' in Śulba surd is technically called "Karaṇi " Thus "Dvi - Karaṇi means $\sqrt{2}$, Tri- Karaṇi = $\sqrt{3}$, Trtīya Karaṇi = $\sqrt{\frac{1}{3}}$ Saptama – Karaṇi = $\sqrt{\frac{1}{7}}$ aṣṭadaśa Karani = $\sqrt{18}$ 'and so on"

It has been noted before that, Sautramaṇiki vedi which is of the shape of an isosceles trapezium, for the face, base and altitude to be respectively $\frac{24}{\sqrt{3}}$, $\frac{30}{\sqrt{3}}$, $\frac{36}{\sqrt{3}}$ and prakaramās Again the dimension of another isosceles trapezium (Aśvamedhika vedi) are stated thus face = $\frac{24}{\sqrt{2}}$ base = $\frac{33}{\sqrt{3}}$ altitude

$= 36\sqrt{2}$ prakramas [2]

$36\sqrt{2} \times \frac{1}{2}(24\sqrt{2} + 30\sqrt{2}) = 1944$

Thus it appears that the rationalization of simple surds was known at that time

Bodhayana says " The measure is to be increased by the third and this (third) again by its own fourth less than thirty forth (of that fourth) this is the (value of) the diagonal of a square (whose side is the measure)"[3]

That is the value of $\sqrt{2}$ according to Bodhyana is $\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3\,4} - \frac{1}{3\,4}\,34$

The same sūtra is also given by Āpastamba (1 6) and (Katyayana) (2 9) 'Śulba sūtras)

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01 The reference are respectively to Ā Ś S 1 5, 2 2 3 3, 9 5

02 Ā SS 6 1

03 A Text book of mathematics II PUC, Karnataka state syllabus (2006) page no 324

Indological Truths

In decimal fraction, the above value of $\sqrt{2} = 1\ 4142156$ According to modern mathematical calculation, $\sqrt{2} = 1\ 4142135$[4] Thus it is clear that the ancient Śulbasūtrakarās attained a remarkable degree of accuracy in calculating the approximate value of $\sqrt{2}$ But Śulbasūtrās not given proof or derivations Thus several modern scientists tried to find out the value of $\sqrt{2}$ with more accuracy

Deviation of value of $\sqrt{2}$ as given by Śulbasūtrakarās. and according to different research scholars given below:

01 Thibaut(1875)[5] - " Suppose they draw a square , the side of which was 17 pādas long, and divided it into 17 x 17 = 289 small squares but only 288 such small squares then the measure of the side would be exact measure of the diagnol of the square, the side of which is equal to 12 (is $12^2 + 12^2 = 288$) when the side of the square is shortened a little, the consequence is that two sides of the square strip is cut off, therefore a piece of that length had to be cut off from the side that the area of two stripes would be equal to one of the 289 small squares Now, $17^2 = 2\ 12^2 - 1$ Thibaut argued, by how much the side 17 must be diminished in order that the square on it may be $2\ 12^2$ exactly Since 2 x 17 x $\frac{1}{34} = 1$ he observed, two strips each of $\frac{1}{34}$ are to be cut off from a square with 17 as side to obtain the square $2\ 12^2$ (i e $2^2 + 12^2$) Hence $\left(17 - \frac{1}{34}\right)^2 = 2\ 12^2$

---

04 B SS 2 12

05 On the Śulba sūtra – journal of the Asiatic Society of Bengal, 44 pt I, no 3 2 p no 239-41

Indological Truths

$$\frac{17-\frac{1}{34}}{12}=\sqrt{2}$$

Again $17 - \frac{1}{34} = 12 + 4 + 1 - \frac{1}{34}$

or $17 - \frac{1}{34} = 12\left(1 + \frac{1}{3} + \frac{1}{3\,4} - \frac{1}{3\,4\,34}\right)$

$$\frac{17-\frac{1}{34}}{12} = 1 + \frac{1}{3} + \frac{1}{3\,4} - \frac{1}{3\,4-34}$$

According to Rodet [6] the approximation adopted by Śulbasūtrakarās may be obtained by successive approximation with following mathematical derivations

$$\sqrt{a^2+r} = a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1}\left(1-\frac{r}{2a+1}\right)}{2\left(1+\frac{r}{2a+1}\right)} + e$$

Where "e" is a fourth term approximation Rodet might have obtain the result as follows

$\sqrt{a^2+r} = a + \frac{r}{2a+1}$ [two term approximation] where $2a + 1$ is the difference of the squares of

a and the next positive approximation, assume

$$\sqrt{a^2+r} = a + \frac{r}{2a+1} + e_1$$

$$= \frac{2a+r+1}{2a+1} + e_1$$

---

6 Rodet, p- 162 – 165

Indological Truths

Squaring and neglecting e_1^2, we get

$$\frac{2(2a+r+1)}{2a+1}\, e_1 = a^2 + r - \left(\frac{2a+r+1}{2a+1}\right)^2$$

$$= r\,\frac{(2a+1-r)}{(2a+1)^2}$$

$$e_1 = r\left(\frac{2a+1-r}{2(2a+1)(2a+1+r)}\right)$$

$$= \frac{\frac{r}{(2a+1)}\left(1-\frac{r}{2a+1}\right)}{2\left(1+\frac{r}{2a+1}\right)}$$

Likewise, the fourth term approximation is obtained Obviously, following above we write

$$\sqrt{2} = \sqrt{1^2+1} = 1+\frac{1}{3}$$

$$\sqrt{2} = 1+\frac{1}{3}+e = \frac{4}{3}+e$$

Squaring both sides and canceling e^2 from both sides we get,

$$\frac{8}{3}e = 2 - \frac{16}{9} = \frac{2}{9}$$

$$e = \frac{2}{9}\times\frac{3}{8} = \frac{1}{12} = \frac{1}{3\,4}$$

$$\sqrt{2} = 1+\frac{1}{3}+\frac{1}{3\,4}$$

let $\sqrt{2} = 1+\frac{1}{3}+\frac{1}{3\,4}+e = \frac{17}{12}+e$

Squaring both side and canceling e^2 from both sides

$$\frac{17}{6}e = 2 - \left(\frac{17}{12}\right)^2 = -\frac{1}{144}$$

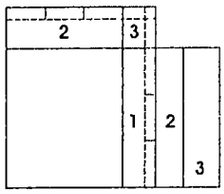
$$e = -\frac{1}{144}\times\frac{6}{17} = \frac{1}{12\,34} = -\frac{1}{3\,4\;\;34}$$

$$\boxed{\sqrt{2} = 1+\frac{1}{3}+\frac{1}{3\,4}-\frac{1}{3\,4\;\;34}}$$

Indological Truths

Datta B.B (1932) Proof [7]:

Datta's proof is an improvement over that of Thibaut and maintains the method of construction follows



The method consists in constructing a square with area equal to the sum of the areas of the two other squares having sides of one unit in length For this one of the two squares is divided into three equal parts by lines drawn parallel to one of it sides Each of these parts forms a rectangular piece of one unit in length and one third unit in width Two of these rectangular part are then joined length wise to the adjacent sides of the other unit square This leaves a square hole of one of the corners of the enlarged unit square This square hole will have a side of one third unit in length The remaining rectangular piece of the divided unit square is again subdivided into there equal parts each forming a square of side one- third unit in length One of the squares is fitted into a square mentioned above Each of the remaining two squares is again subdivided into four equal rectangular pieces having length of $\frac{1}{3}$ unit and width of $\frac{1}{3\,4}$ unit Eight of these small rectangular pieces are placed length - wise side by side on the two adjacent sides of the enlarged square with four on each side This again leaves a square hole at the corner having a side of length $\frac{1}{3\,4}$ unit Now two equal strips have to be deducted from the two adjucent sides of the enlarged square under construction as shown in the figure below, The width of each of the strips is therefore given by

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07 The Science of Śulba, a study in early Hindu Geometry - Calcutta University 1932 by B B Datta (2)1932

Indological Truths

$$\frac{\left(\frac{1}{3\,4}\right)^2}{2\times\left(1+\frac{1}{3}+\frac{1}{3\,4}\right)} = \frac{1}{3\,4\;34}$$

Hence $\sqrt{2}$,the side of the desired square is given approximately by $1+\frac{1}{3}+\frac{1}{3\,4}-\frac{1}{3\,4\,34}$

Gurjar (1947)[8]

a] The value of $\sqrt{2}$ was obtained by Tannery's - R process Āpastamba Śu s (3 15) gives correct as follows

$\left(1+\frac{1}{2}\right)^2 = 2\frac{1}{4}$ which is greater than 2

Hence the square of (1 + 1/3) was tried ,

But $\left(1+\frac{1}{3}\right)^2 = \frac{16}{9} < 2 \qquad 2 - \frac{16}{9} = \frac{2}{19}$

A quantity X was taken so that $\left(1+\frac{1}{3}+X\right)^2 = 2$

$$\frac{16}{9}+\frac{8x}{3}+X^2 = 2 \quad \text{Omitting } X^2, \frac{8x}{3} = 2-\frac{16}{9} = \frac{2}{9}$$

$$X = \frac{2}{9}\times\frac{3}{8} = \frac{1}{3\times 4}$$

$\sqrt{2} = 1+\frac{1}{3}+\frac{1}{3\times 4}$ This is the second approximation

$$\left(1+\frac{1}{3}+\frac{1}{3\times 4}\right)^2 = \left(\frac{17}{12}\right)^2 = \frac{289}{144} > 2 \quad 2 - \frac{289}{144} = -\frac{1}{144}$$

8.Gurjar L.V. (1947) " Ancient Indian Mathemetics and Vedha p – 30-36

Indological Truths

The Y is taken such that

$$\left(1+\frac{1}{3}+\frac{1}{3\times 4}+Y\right)^2=\left(\frac{17}{12}+Y\right)^2=\frac{289}{144}+\frac{34Y}{12}+Y^2 \text{ omitting } Y^2$$

$$\frac{34Y}{12}=2-\frac{289}{144}=-\frac{1}{144}\quad Y=\frac{-1}{12\times 12}\times\frac{12}{34}=-\frac{1}{3\times 4\times 34}$$

$$\sqrt{2}=1+\frac{1}{3}+\frac{1}{3\times 4}-\frac{1}{3\times 4\times 34}$$

b) Heron's formula may have been used This method consists of splitting the quantity under the radical sign into two parts one complete and another the remaining part

$\sqrt{A^2+B}=A+B/2A$ approximately

Thus $\sqrt{2}=\sqrt{1+1}=1+1/2$ This is the first approximation

But $\left(1+1/2\right)^2=\left(3/2\right)^2=\frac{9}{4}>2$

$\left(1+\frac{1}{3}\right)^2=\left(\frac{4}{3}\right)^2=\frac{16}{9}$ is taken

$\frac{16}{9}<2$ by $2/9$ $\quad\sqrt{2}=\sqrt{\frac{16}{9}+\frac{2}{9}}=\sqrt{\left(\frac{4}{3}\right)^2}+\frac{2}{9}=\frac{4}{3}+\frac{(2/9)}{2(4/3)}$

But $\sqrt{2}=\frac{4}{3}+\frac{1}{3\times 4}=1+\frac{1}{3}+\frac{1}{3\times 4}$ is the second approximation

$=\frac{17}{12}-\frac{1}{3\times 4\times 34}$

$=1+\frac{1}{3}+\frac{1}{3\times 4}-\frac{1}{3\times 4\times 34}$ is the third approximation

Let us get the 4th approximation by extending this procedure

$$\left(\frac{577}{408}\right)^2=\frac{332929}{166464}>2 \text{ by } \frac{1}{166464}$$

$$\sqrt{2}=\sqrt{\frac{332929}{166464}-\frac{1}{166464}}=\frac{577}{408}-\frac{1/166464}{2\times 577/408}$$

$$=\frac{577}{408}-\frac{1}{408\times 2\times 577}$$

$$\sqrt{2}\quad 1+\frac{1}{3}+\frac{1}{3\times 4}-\frac{1}{3\times 4\times 34}-\frac{1}{3\times 4\times 34\times 2\times 577}=\frac{17}{2}$$

Indological Truths

Ayyangar ((1933)[9]

The value of $\sqrt{2}$ was obtained by following the usual method of obtaining the square root of a figure and that is

I) $2\left(1+\frac{1}{3}+\frac{1}{3\times 4}-\frac{1}{3\times 4\times 34}\right)$

$\frac{+1}{2+\frac{1}{3}}$ $\frac{-1}{1}$

$\frac{+\frac{1}{3}}{2+\frac{2}{3}+\frac{1}{3\times 4}}$ $\frac{-\frac{7}{9}}{\frac{2}{9}}$

$\frac{-2/9+\frac{1}{9\times 16}}{-\frac{1}{9\times 16}}$

$+\frac{1}{3\times 4}$

$2+\frac{2}{3}+\frac{2}{3\times 4}-\frac{1}{3\times 4\times 34}-\frac{1}{9\times 16}+\frac{1}{(3\times 4\times 34)^2}$

$\sqrt{2}=1+\frac{1}{3}+\frac{1}{3\times 4}-\frac{1}{3\times 4\times 34}$

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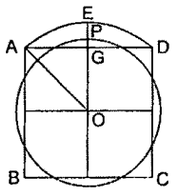
09 Ayyangar A, A K " Some Glimpse of Ancient Hindu Mathemetics " VDI 1 No 1 P 1- 18

Indological Truths

Application of value of $\sqrt{2}$ [10]

Let ABCD be the given square and O is its center The half diagonal OA drawn over the east - west line OE

such that OA = OE Then a circle with radius OFF equal to OG plus $\frac{1}{3}$ of GE i e GF is drawn to give the required circle



Here, radius = OF = OG + GF

$$= OG + \frac{1}{3} GE$$

$$= OG + \frac{1}{3}(OA - OG)$$

S N Sen and A K Bag (See Bibliography) solved the problem of finding the area of transformed circle as follows

let '2a' be a side of the square ABCD

$$OF = a + \frac{1}{3}\left(a\sqrt{2} - a\right)$$

$$\text{or } r = a\left[1 + \frac{1}{3}(\sqrt{2} - 1)\right] \text{ where } OF = r$$

$$\text{or } r = \frac{a}{3}\left(2 + \sqrt{2}\right)$$

As already mentioned

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3\,4} - \frac{1}{3\,4\,34}$$

$$= \frac{577}{408} = 1\,4142156$$

Thus in the transformation of a square into a circle, the value of $\sqrt{2}$ is applied This is the application of $\sqrt{2}$ by Sulba sūtrakarās in sacrificial altars

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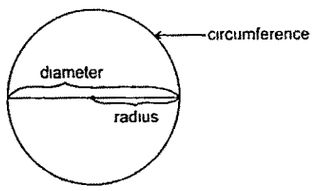
10 The scope and Development of Hindu Ganitha Vol v p – 512

Indological Truths

It will be naturally interested to know how the value of $\sqrt{2}$ was determined in that early period like period of Śulbasūtra to such a high degree approximation Unfortunately there is no proof in Śulbasūtras adopted by them for this purpose and it is not of their tradition So it is difficult to guess it But however, Thibaut, Rodet, Datta, Ayyangar, Gurjars etc tried to find out the deviation of value of $\sqrt{2}$ and by seeing their deviations which mentioned above Anyhow, Sulbasūtrakarās[11] known the value $\sqrt{2}$ with a remarkable degree of accuracy is one of the greatest contribution to Gometry

Value of π - Sulbasūtrakarās know the value of π which is very much essential in Geometry 'π' is a symbolic word in geometry usually applied while finding the area of a circle



In a circle,

$$\pi = \frac{\text{Circumference}}{\text{Diameter}}$$

Here circumference in the line drawn by a cord with a specific radius from the centre point as shown in the figure If we take the double of its radius it becomes diameter

(i) In Sulbasūtra [12] while mentioning about the sacrificial pits, says that the sacrificial posts are 1 pāda (each) in diameter and the circumference base of the pits is 3 pādas

$$\text{Therefore } \pi = \frac{\text{Circumference}}{\text{Diameter}} = \frac{3}{1} = 3\ 00$$

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11 A text of mathematics (Karnataka State) S S L C page no 234

12 B SS 2 9 (I 58), Ā ŚS 3 2, K ŚS 3 11, M ŚS 1 8

Indological Truths

This is undoubtedly a rough value known to Śulbasūtrakarās In the problem of circling a square and squaring of the circle [13], Bodhayana has given three other values which are a little better when compared with the correct value of π (3 14159)

Modern correct value of π is $\frac{22}{7}$ i e 3 14 159

(ii) An approximate method of obtaining a square of an area equal to that of the given circle is given as follows [14]

It is stated that the length of the side of a square of area equal to that of the given circle is 13 parts out of 15 parts in which the diameter of the circle is divided

let us assume that the diameter of the given circle is 'd' Then the length of the side of the square of equal area will be $\frac{13}{15}d$

According to mathematical rule

Area of a the circle = $\frac{\pi d^2}{4}$

Since Area of the square = Area of the circle

$$\frac{\pi d^2}{4} = \left(\frac{13}{15}d\right)^2 \text{ i e } \frac{\pi d^2}{4} = \left(\frac{13}{15}\right)^2 d^2$$

$$\pi = 4\left(1 - \frac{2}{15}\right)^2 = 3\,004$$

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13 B B Datta(2) p 149

14 B SS 2 -9, 2-10

Indological Truths

(vi) If we consider circling the square of Bodhyana[15]

Area of the square = x^2= area of the circle = πR^2

$$x^2 = \pi \left[\frac{x}{2} + \frac{1}{3}\left(\frac{x}{\sqrt{2}} - \frac{x}{2}\right)\right]^2$$

$$= \frac{\pi}{36} x^2 \left(6 + 4\sqrt{2}\right)$$

$$= \frac{\pi}{36} x^2 \left(6 + 4 \times \frac{577}{408}\right)^{16}$$

$$x^2 = \pi x^2 \left(\frac{1189}{3672}\right)$$

$$\pi = \frac{3672}{1189} = 3\ 0883$$

(vii) According to Bodhayana [17] in another way the relation between the length of the side (say x) of a square with that of the diameter (D) of a circle of equal

$$x = D\left[\frac{7}{8} + \frac{1}{8 \times 29} - \frac{1}{8 \times 29 \times 6} \quad \frac{1}{8 \times 29 \times 6 \times 8}\right]$$

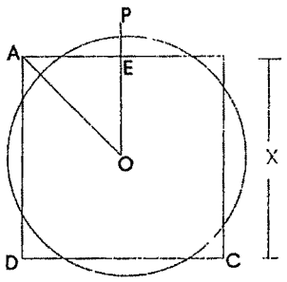
$$= 0\ 8787D$$

Area of square = $(0\ 08787\ D)^2$

Area of Circle = $\pi\ D^2 / 4$

As the area of the square and circle are equal

$$\frac{\pi D^2}{4} = 0\ \ 7772\ D^2 \qquad \pi = 3\ 0885$$



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15 B SS 2 11, Ā ŚS 3 6-8, K ŚS 3 14 M ŚS 10 3-2

16 $\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \times 4 \times 34} = \frac{577}{408}$

17 B ŚS 2 09

Indological Truths

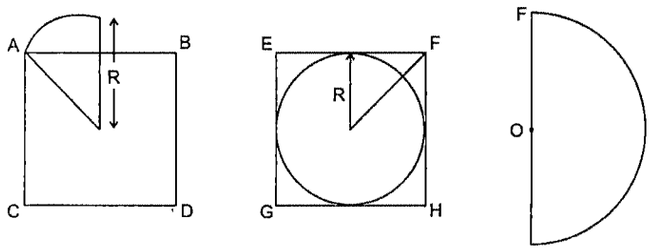
Dvarakanatha Yajva's [18] commentary on the BŚS has improved upon results (ii) and (iii) by introducing certain corrections as follows

$$\pi = \frac{4}{\left[1 + \frac{1}{3}(\sqrt{2}\ 1\ 1)\right]} 2 \times \left(\frac{118}{117}\right)^2 = 3\ 141109$$

and $4\left(1 - \frac{1}{8} + \frac{1}{8\ 29} - \frac{1}{8\ 29\ 6} + \frac{1}{8\ 29\ 6\ 8}\right)^2 \times \left(1 + \frac{1}{2} \cdot \frac{3}{133}\right)^2$

$= 3\ 157991$

Manava śulba sūtra [19] gives a construction to draw a semicircle of are equal to that of the given square Let ABCD is a given square Draw a circle of area equal to that of the square ABCD with O as centre Draw a square EFGH circumscribing the circle Join OF Draw a semi circle of radius OF It has an area equal to that of the square ABCD as shown in the figure below



Let us assume that the length of the side of a square = X

The radius of the circle of equal area = $\frac{\sqrt{2x} + 2x}{b}$ = say R

The length of the side of the circumscribing square = $\sqrt{2}R$

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18 B Ś S 2 10

19 M Ś S 10 1 1 8

Indological Truths

The length of it one - half hypotenuse (i e OF) = $\sqrt{2}R$

A semicircle of radius $\sqrt{2}R$ is drawn

The area of the semicircle = area of the square of side X

$$\frac{\pi\left(\sqrt{(2)}\ R\right)^2}{2} = x^2 \text{ but } R = \frac{\sqrt{(2x)} + 2x}{6}$$

$$x^2 = \pi\left[\frac{\sqrt{2}\ x + 2x}{6}\right]^2$$

$\pi = 3\ 088$

(vi) According to M Ś S [20] the dimensions of Gārhapatya , Āhavanıya and Daksınāgnı are as given below

Āhavanıya is a square of one Araṭını, Gārhapatya is a circle of radius 14 angula-l yava $\left(is\ 13\ \frac{7}{8}\ \text{angula}\right)$ and Daksınāgnı is semicircular of radius $19\frac{1}{2}$ aṅgulas

Area of Āhavanıya = Area of Gārhapatya

$\pi\ (13\ \frac{7}{8})2 = 5765959$ angular
$= 2\ 99$

Area of semicircular Daksınāgnı = Area of Gārhapatya

$$\frac{\pi\ (19\ 5)2}{2} = 576$$

$\pi = 3\ 029$

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20 M ŚS 2 10

Indological Truths

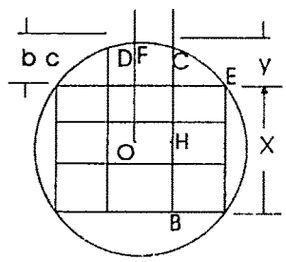
Thus it is obvious that for developing the construction for drawing a semicircle of area equal to that of the given square given square Mānava śūlabakāra had assumed the value of $\pi = 3\ 088$

(vii) M SS had given as the construction of circling a square of equal area "He shall divide a square into nine parts the segments (of the circumscribed circle) into three parts each (by lengthing the lengths of the part of the square), he shall remove the fifth part from the height (of such a lengthened line measured from the middle), together with dust'(circle with as radius the line from centre to the mark at the fifth part will be) as large as (the square)"

This can be explained in modern way as follows

Let us assume that the length of the side of the given square is X The circle circumscribing the square is say of radius $R = x/\sqrt{2}$ Divided the square into nine small squares of equal area Line BA was extended to cut the circle at C, AC = Y

Draw OD perpendicular from the centre O of the circle to the side GE of the square and extended it to meet the circumference of the circle at F



$AD = FC = Z,\ DF = B$

$AD = Z = \frac{x}{2} - \frac{x}{3} = \frac{x}{6}$

A

$DF = b = R - \frac{x}{2} = \frac{x}{\sqrt{2}} - \frac{x}{2}$

$CA = y = b - R + \sqrt{R^2 - Z^2}$

$= \frac{x}{\sqrt{2}} - \frac{x}{2} - \frac{x}{\sqrt{2}} + \sqrt{\frac{x^2}{2} - \frac{x}{36}}$

$= \sqrt{\frac{17}{36}x^2} - \frac{x}{2} = x\left(\frac{4\frac{1}{8}}{6} - \frac{1}{2}\right)$

$= \frac{3}{16}x$

Indological Truths

The radius of the circle of equal to that of the square = $\frac{X}{2} + \frac{3}{16}X - \frac{1}{5} X \frac{33}{48} X = \frac{11}{20}X$

The area of this circle $= \pi\left[\frac{11}{20} x\right]^2 =$ area of the side $X = X^2$

$$\pi \left(\frac{20}{11}\right)^2 = 3\ 3$$

It informed that instead of decreasing the length H C by the 1/5 that if it is decreasing by $1/6^{th}$ then a better approximation of value of π is attained

With this connection

The radius of the circle = $\frac{X}{2} + \frac{3}{16} X - \frac{1}{6} X \frac{33}{48} X = \frac{165}{288} X$

The area of the circle = $\pi = \left(\frac{165}{288} X\right)^2$ = area of square = X^2

$$\pi \left(\frac{288}{165}\right)^2 = 3\ 047$$

As per Bodhayana $\sqrt{2}$ is given by

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3\ 4\ 34}$$
$$= \frac{577}{408} = 1\ 4142156$$

Then the Bodhayana's [21] more refined value of π is given by

$$\pi = 4\left(1 - \frac{1}{8} + \frac{1}{8\ 29} - \frac{1}{8\ 29\ 6} + \frac{1}{8\ 29\ 6\ 8}\right) = 3.0885$$

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21 B ŚS 1 60 (Com) by Dvarakanatha

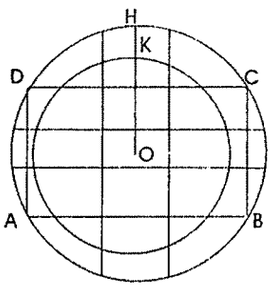
Indological Truths

Using the above value of $\sqrt{2}$ and π the are a of the transformed circle $= \pi r^2 = 3\ 9989a^2$ which is close agreement with the area of the given square $4a^2$ this is the application of value of π in the transformation of a square into a circle

While circling the square R C Gupta has recently improved value of π discovered a fine in Mānava Śulba sūtra[22]

"Divided the square into nine parts by drawing three (parallel) lines and from two sides, drop out the fifth portion (in centre) and fill it up with loose earth" This can be explain d as follows

(The elongated trisecting lines will) divide the arcual segments (of the circumscribing circle) into three parts each leave out the fifth part from the altitude (OH) The circular disc formed by the remainder OK as radius is equal to that (square) Let OH to the radius of the circum - circle of the square, ABCD (to be converted into an equal circle)



22 MŚS (0118)

Indological Truths

Squaring circle and circling and circling the square

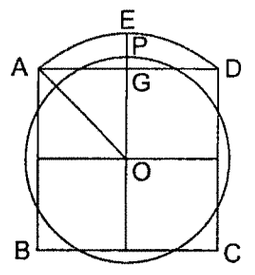
Since the area of Gārhaptya fire (which is of circular form) was to be same as that of the Āhavanīya fire (which is of square form), Śulbasūtrakarās know method of transforming *a* square into a circle or circle into a square

The transformation of a square into a circle is given by Bodhāyana[23], Āpastamba Katyāyana and Mānava Katyāyana and Mānava[24] followed the same method of Bodhāyana

The method of Bodhāyana has given as follows '(If it is desired to transform a square into a circle (a cord of length) half the diagonal (of the square) is stretched from the center to the east (a part of it lying outside the eastern side of the square) with one third (of the part lying outside) added to the remainder (of the half diagonal), the (required) circle is drawn'

This can be explained mathematically as followes

let us ABCD be the given square and O the centre The half diagonal OA is drawn over the east- west line OE, such that OA = OE Then a circle with radius of equal to OG plus $\frac{1}{3}$ of GE is i e GF is drawn to give the required circle



Here radius = OF = OG + GF

$$= OG + \frac{1}{2} GE$$

$$= OG + \frac{1}{2} (OA - OG)$$

23 B ŚS 1 58

Indological Truths

let 2a be the side of the square ABCD

$OF = a + \frac{1}{2}(a\sqrt{2} - a)$

or $r = a\left[1 + \frac{1}{2}\left(\sqrt{2} - 1\right)\right]$ where OF = e

or $r = \frac{a}{3}\left(4_2/\sqrt{2}\right)$

Now r = OK (4/5) OH = (4/5) OD = $2\sqrt{2}$ S/5

Where 'S' is the length of a side of the given square Also the construction assumes $\pi r^2 = S^2$, Hence we get the implied approximation $\pi = \frac{25}{8} = 3\ 125$

This is the best of the various values found by the Śulbasūtrakarās

Conclusion:-

Thus all the values of π can be tabulated as shown below

		Reference	Values of π
i)	B Ś S	1 113	3 00
ii)	B S S	1 59	3 088
iii)	B Ś S	1 59	3 088
iv)	B S S	1 60	3 004
v)	M Ś S	10 1 1 8	3 088
vii)	M Ś S	10 3 2.05	3 047
viii)	M Ś S	1 27 (Datta – commentator) 1932	3 16049
ix)	M Ś S	11 5 (R C Gupta)	3 125

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24 ĀŚS 3 2 , KŚS 3 11 , MŚS 1 8

Indological Truths

Thus ,the value of π known to Bodhāyana seems to be 3 088 R C Gupta's value of π is 3 125 The modern mathematicians have tried to find out the exact value of π, but not of succeeded yet in mathematics, the value of π is taken as $\frac{22}{7}$[25] while solving problem of geometry or anything else But at the period between 800BC – 200 BC, Śulbasūtrakarās able to find out the value 3 088 which is approximately nearer to the modern value of 3 14

Thus the value of Sulbasūtrakarās was undoubtedly a rough value However modern scholars like Dvarakanatha, R C Guptha has improved upon the value of π by introducing certain corrections But Āryabhata - I of 476 A D in his Ārya bhatīyam [26] had given the accurate value of π as

$$\pi = \frac{\text{Circumference}}{\text{diameter}} = \frac{62832}{20000} = 3\ 1416$$

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25 Text book of Mathemetics of π (S S L C) Karnataka State Syllabus page - 232

26 चतुरधिक शतमष्टगुण्म द्विषष्टिस्तथा सहस्राणाम

अयुतद्वयविष्कम्भस्यासन्नो वत्तपरिणाहः ॥ **Ary. ii – 10 B B.Dutta (2) P 149**

Indological Truths

Chapter - 8

Transformation of areas and Mathematical theorems

Śulbasūtras involve geometrical propositions and problems relating to rectilinear figures, their combinations and transformations etc Several sūtras of Bodhāyana, Āpastamba Kātyāyana and Mānava gives explanation like mathematical theorems in Geometry There were also several transformation of areas like square into a rectangle, an isosceles trapezium or circle into a square, or vice versa These evidences uphold to conclude that Śulbasūtras are manuals of geometry also

Construction of a square being sum of clifference between two square:[1]

Baudhāyana says, "if it is desired to combine two squares of different measures a (rectangular) part is cut off from the larger (square) with the side of the smaller, the diagonal of the cut off (rectangular) part is the side of combined square Alternatively if it is desired to combine two squares of different measures, a rectangle is formed with the side of the smaller (square as breadth) and that of the larger (as length) the diagonal of the rectangle (thus formed) is the side of the combined square

Here these technical terms mentioned by Baudhāyana, (i) harsīyasah (ii) varsīyasah, (iii) vrddhram 'The word harsīyasah means the side of the smaller square, 'varsīyasa' means the side of the larger square and 'vrddhram' means the rectangular portion (i e also as dīrghacaturasram)

Method of combination (Samāsa)[2]

For the combination of a smaller square EBGF with another square ABCD, this rule of Bodhāyana suggest that the rectangular portion ABGH is cut off by the side

1 BŚS 2 1-2

2 BŚS 2 1

Indological Truths

of the smaller square whose side is equal to BG Then AG of this cut-off portion will be the side of the combined square as in the figure (1)

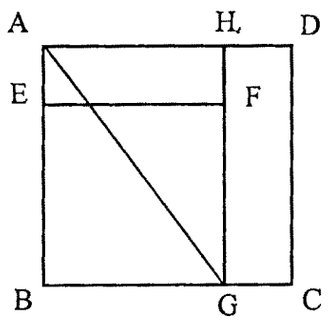


fig (1)

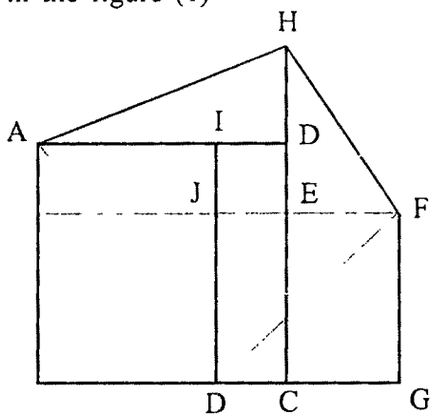


fig (2)

Evidently, AG2=AB2++BG=sum of two squares

The same method is also given by Āpastamba and Kātyāyana But no proof has suggested to this proposition

Proof B B Datta[3] has suggested the following proof of this proposition as shown in the second figure

Sq ABCD+Sq ECGF

=ΔABO+ΔAOI+ΔOFG+ΔOFJ+□IJED

=ΔADH+AOI+ΔHEF+ΔOFJ+□IJED

=□AOFH

or $AB^2+CG^2=AO^2$

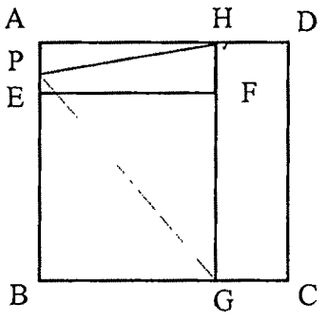
Method of differences (nirhāra)

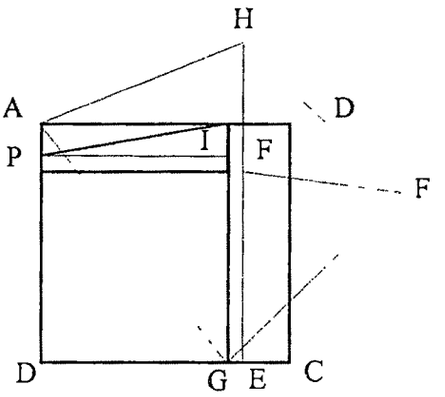
To construct a square equal to the difference between a smaller square EBGF and other square ABCO, the rule of B Ś S suggests that the rectangle portion ABGH is cut off by the side BG of the smaller square, then the side GH of the cut off

3 B B Datta, (2), 79

Indological Truths

portion is allowed to fall on AB, and P is the point where it falls Here GH=GP Then BP is the side of a square which is equal to the difference of the square ABCD and EBGI





Evidently,

$BP^2 = GP^2 - BG^2$

$= GH^2 - BG^2$

$= AB^2 - BG^2$ — (1)

= difference of two squares ABCD and EBGF

The method also given in Āpastamba and Kātyāyana

The following proof based on the knowledge of th Śulbasūtra is given by Datta-II This can be given as follows

Now, sq PGFH = 4 tr PGI+sq IJKL

= 2 tr PGI+2 tr PGI+sq IJKL

= rect PBGI+rect PBGI+sq IJKL

= (rect PBGI+sq IJKL)+ rect PBGI

= (rect PBGI+sq IJKL)+ sq MBGI+rect PMJI

= (rect PBGI+sq IJKL+rect PMJI)+ sq MBGJ

= (rect PBGI+sq IJKL+rect JGEK)+ sq MBGJ

Indological Truths

$$= \text{Sq PBEL+sq MBGJ}$$

$$\text{or sq PBEL} = \text{sq PGFH-sq MBGJ}$$

$$= BP^2\ PG^2=BG$$

$$\text{ór } BP^2=AB^2-BG^2$$

This is the solution regained [as mentioned in the equation (1)]

Thus with this method the combination and difference of two different squares may be constructed

1. To transform a rectangle into a square:

Bodhāyana gives the method to transform a rectangle into a square This may state as follows

If you wish to transform a rectangle into a square made its breadth as the side of a square, divide the reminder into two parts and changing the place (of the farther of them) and inverting, add it on the other side of the square Then adding a (square) portion, fill up that (the empty space in the corner) It has been taught (before) how to deduct it the added square from the full square thus formed

The same method is taught also by Āpastamba- "If you wish to transform a rectangle into a square, cut off (from the rectangle a square portion) with its shorter side Divide the other portion into two parts Take the farther portion on the east and add it on the south (of the square portion) Complete the (square) figure by introducing a (small square) piece The method for its deduction has been taught "[4]

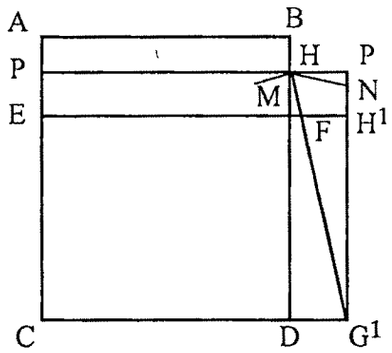
In modern methematical way the above method can be explained as follows

Let it be required to change the rectangle ABDC into a square From the longer side AC cut off a portion CE equal to the breadth CD of the rectangle Complete the square CDFI Divide the remaining part ABFE of the given rectangle into two halves by the line GH Take the remaining half ABHG and place it after inversion

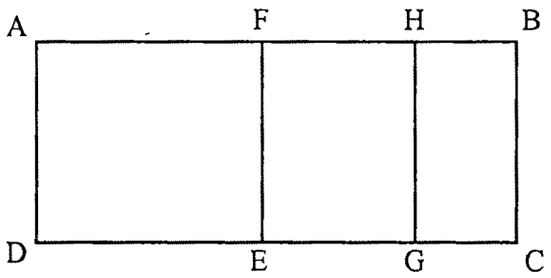
4 BŚS 1-58.

Indological Truths

on the other side of the square CDFE in the position DG^1H^1F - complete the square $CGPG^1$ by adding the portion HPH^1F The given rectangle is easily found to be equal to the difference of the two squares GPG^1C and HPH^1F This difference can be found by the method taught before That is, draw a circle with centre G^1 and radius G^1P cutting at M Draw MN perpendicular to G^1P Then $G^1N^2=G^1M^2-MN^2=G^1P^2-HP^2$ so that G^1N is the side of the square which is equivalent to the given rectangle ABDC as shown in the figure



Āpastamba[5] Kātyāyana[6] suggests a different procedure for the transformation of a rectangle whose length much exceeds its breadth, combine these squares into one square, add to this the remaining portion (of the rectangle) after transforming it suitably " It can be shown in figure as follows



This is certainly no improvement on other method It will, in fact, require more

5 ĀpŚS 27

6 KŚS 3-2

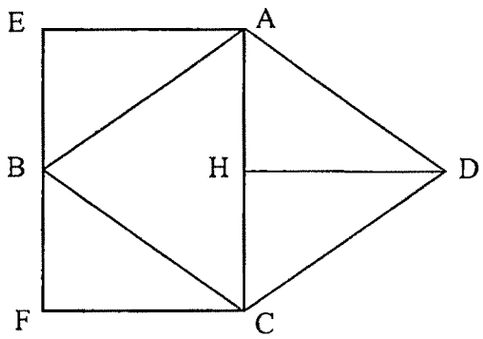
Indological Truths

operations to complete the desired transformation The first method is very general and is equally available for all cases of transformation of a rectangle into a square

2. To transform a square into a rectangle:

Bodhāyana[7] gives the following rule for transforming a square into a rectangle

"If you wish to tranform a square into a rectangle, divide it by the diagonal Divide again one part into two and add them suitably so as to fit the two sides (of the other half)



The same method is also taught by Kātyāyana[8] This method is much circumscribed in as much as it transform the given square into a rectangle in which the length is double the breadth and is itself equal to the diagonal of the given square

3. To transform a square into a rectangle which shall have a given side:

To transform a square into a rectangle which shall have a given side Āpastamba gives the following rule "If you wish to transform a square into a rectangle (cut off from it a rectangular segment) by making a side as long as you wish (a side of the transformed rectangle to be) What remains in excess, should be added (to the former) as suitable as to fit[9]

A similar rule is given also by Bodhāyana[10] Or else if the square is to be transformed into (a rectangle) of this (i e one specified) side, cut off (from the square) a segment by that side What remains in excess should be added along the other side

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7 BŚS 1 52

8 ĀpŚS 3 4

9 ĀpŚS 3 1

10 BŚS 1 53

Indological Truths

The latter portion of both the rules is obscure in as much as the operations to be employed have not been explained fully They were doubtless handed down by oral tradition

This rule can be applied as follows

Let ABCD be the given square and M the given length which is greater than a side of the square Produce DA and CB to E and F respectively so that DE=CF=M Join EF and complete the rectangle EFCD Draw the diagonal EC cutting AB at P Then PB will be the breadth of the transformed rectangle Through P draw the straight line HPG parallel to ED or FC Then HFCG is the rectangle which is equivalent to the square ABCP and whose side CF is equal to the given length M For $\Delta EFC=\Delta EDC$, $\Delta EHP=\Delta EAP$, $\Delta PBC=\Delta PGC$

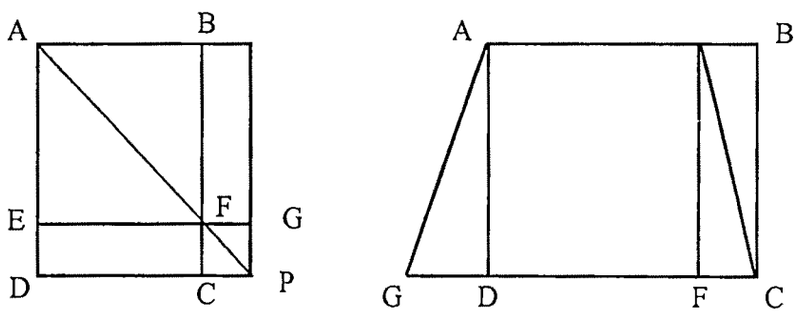
Parallelogram HFBP=parallelogram APGD

Hence parallelogram HFCG=square ABCD

4. To transform a square or a rectangle into an isosceles trapezium which shall have a given face:

Bodhāyana gives the following rule for the transformation of a square or a rectangle into an isosceles trapezium or for what they call "shortening of a square or a rectangle on one side "

"If you wish to make a square or a rectangle shorter on one side (cut off a rectangular portion) by making the shorter length side Divide the remainder by the diagonal and place (the two portions) on either sides (of the portion cut off) after inverting"[11] as shown in the figure



11 BŚS 1 55

Indological Truths

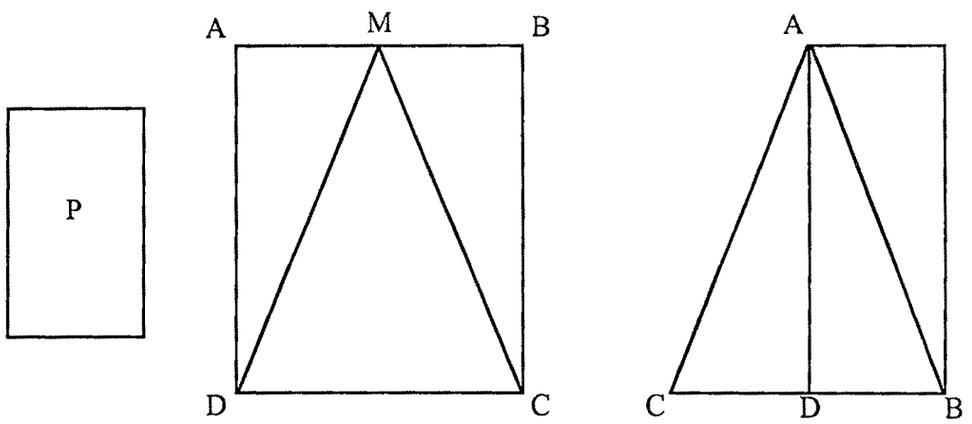
5. To transform a square or rectangle into a triangle:

"If you wish to transform a square or a rectangle into a triangle, construct a square whose area will be twice as much as the area of the figure (to be transformed) Fix a pole at the middle of its eastern side Having fastened at it two ties (of two cords) stretch the cords towards the two western corners Cut off the portions lying beyond these cords [12]

Let P be the given rectangle figure to be transformed Draw the square ABCD so that its area will be twice that of P Let M be the middle point of AB Join MD and MC Then triangle MCD is equal to the rectangular figure P For each is equal to the half of the square ABCD as shown in figure (a)

6. To transform an isosceler triangle into a square.

"If you wish to transform an isosceles triangle into a square, cut off its northern half by the middle line, then place it on the opposite side after inverting By the method of constructing a square equal to a rectangle, construct the square [13] This is the method of construction as shown in fig (b) (Let ABC be an isosceles triangle Draw the median AD Take the half ADC and place it after invesion in the position BCA Then the rectangle AGBD is equal to the sosceles triangle ABC Now transform the rectangle AGBD into a square by the method given before)



12 BSS 156

13 KŚS 45

Indological Truths

7. To transform a square or rectangle into a rhombus

"If you wish to transform a square or a rectangle into a rhombus, construct a rectangle which shall have an area twice as much as the area (of the figure to be transformed) Fix a pole at the middle of its eastern side Having fastened at it two ties (of two cords), stretch the cords towards middle (points) of the northern and southern sides (of the rectangle) Cut off the portions lying beyond (these cords) Thereby it is also explained the construction of the other triangle "[14]

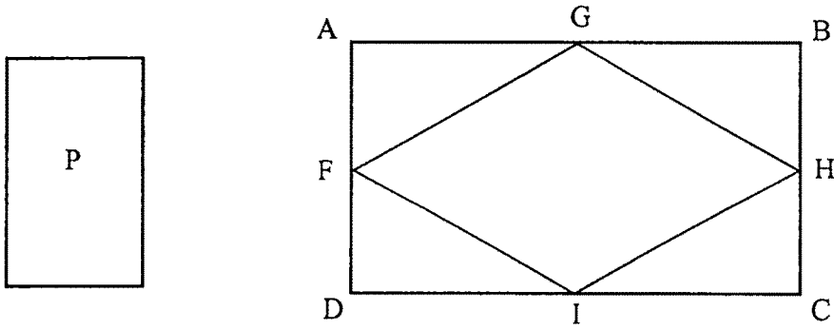
Let P be a rectangular figure Draw the rectangle ABCD so that its area will be double that of P Let G, H, E, F be the middle points of the sides AB, BC, CD, DA respectively Join GH, HE, EF, FG Then the rhombus GHEF is equal to the rectangular figure This method is taught by Bodhāyana, Āpastamba and Kātyāyana

To transform a rhombus into a square

Kātyāyana observes

"If it be the case of transformation into a square of a rhombus, bisect it by its transverse middle line Then construct as before "[15]

That is the rhombus is first divided into two isosceles triangles, by drawing a diagonal The triangles are then transformed into squares by the method given before Finally, the two squares ae combined into one square



14 BŚS 45

15 KŚS 44

Indological Truths

Mathematical theorems in Śulbasūtras:

Śulbas are manuals for the construction of altars which are necessary in connexion with the performance of various sacrifices The fire-altars for the sacrifices are prescribed to be different shapes For example (i) Praugu citi is constructed in form of an isosceles triangle (ii) Ubhaya prauga citi is in the form of rhombus (iii) Rathacakraciti is in the form of a chariot wheel (iv) Paricāyya citi is in the form of a circle (v) Śaṃśa citi is in the form of a pyre isosceles trapezium [16] For the accurate construction of these altars knowledge of geometry is very essential Therefore Śulbasūtras describe some theorems which are same as that of modern mathematical theorems

Theorem 1 : A given finite straight line of given length can be divided into any number of equal parts:

In Śulbasūtras often times this theorem is applied For example, in B Ś S a line of given length is divided into two parts[17] and to transform a circle into a square the diametre of a given circle is divided into 8 equal parts, each of these again into 29 parts and again, it is reduced by 28 of them and further by the sixth (of the part left) less the eighth (of the sixth part) [18]

There are indeed numberous such instances In Ā Ś S 'A cord of length equal to a given measure is increased by itself so that the whole length is divided into three parts of half the measure each [19] Now it will be naturally asked how it was used to be done Certainly not arithmetically It can be explained as below

Take a cord of the length equal to the given line Join the ends of the cord and obtain a mid-point of it Join the two ends of the cord at its mid-point and obtain

16 तण्डैके । एतयः विकृत्याऽभिमन्त्र्यान्या चितिं चिन्विन्ति द्रोणचितिं वा श्यचक्रचित वा कङ्कचित वा प्रउगचित वो भयतः प्रउग वा समुह्यपुरीष वा न तया कुर्याद्यथा पक्षपुच्छवन्त गर्भ परिवृश्चेत्ता दृक् तत् तस्मादेनत सुपर्णचितमेव चिनुयात् । T S VI 7 2 8

17 B Ś S 1 22

18 B Ś S 1 59

19 Āp Ś S 1 2

Indological Truths

quarter points on the cord By repeating this procedure a line of given length can be divided into any even number of parts of equal lengths Suppose a line is to be divided into 4 parts of equal length, the cord of the length equal to that of the given line is divided into 8 parts of equal length If two parts are considered as one part this line is divided into 4 parts of equal length This line of given length could be divided into any (either odd or even) number of parts of equal length

To divide a line of given length into any fraction of its length, the ties are made at both ends of a cord twice the measure and mark is point shorter by one-fourth, a mark is given [20] Sometimes the given straight line is such that the parts when expressed arithmatically will contain big fractions Thus side of a square of 96 angulas has to be divided into 7 parts [21]

Theorem 2 : A circle can be divided into any number of parts by drawing diameters:

In the Śulba, we have several instances of the division of a circle into a specified number of parts For instance, it is said that the Dhisnya may be square or circular in shape and one of them For example, Āgnīdhriya, has to be divided into nine parts [22] Now in the case of the square shape of the altar, it is easily divided into 9 smaller squares by cross-line drawing, cross-line through the points of trisection of the sides (fig 1) When it is circular, there is described a small circle about its centre and the annules is then divided into 8 equal parts by drawing from diameters (see fig 2) Similarly in an alternative circular shape of the Mārjālīya fire, the circle has to be divided into 6 equal parts [23] Circular annules has been divided into 32 equal parts [24]

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20 B Ś S 1 30-32

21 B Ś S ii 64

22 B Ś S 7 10 (ii 74)

23 B Ś S ii 77

24 B Ś S iii 200

Indological Truths

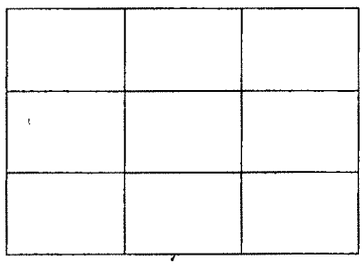


fig (1)

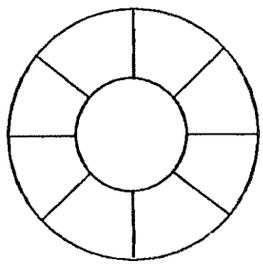
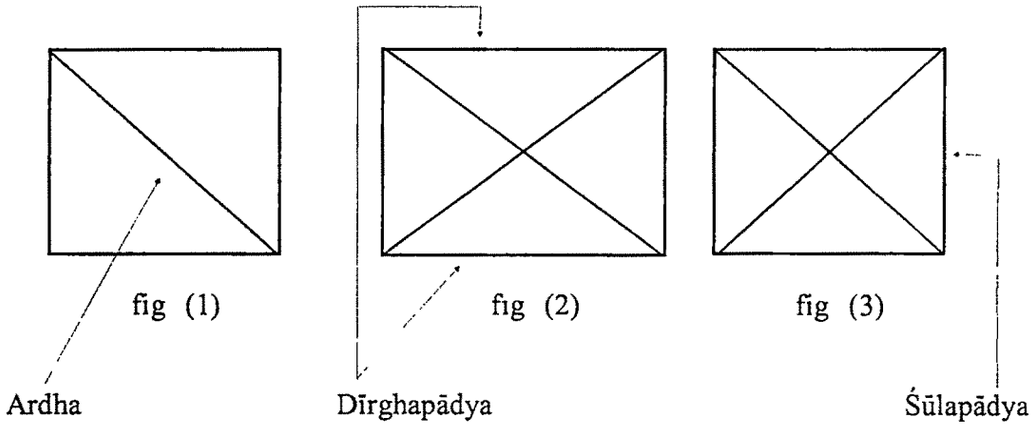


fig (2)

Theorem 3 : The diagonal rectangle bisect one another and they divide the rectangle into four parts:

The portion of a rectangle or of a square divided by its diagonal is termed ardha (or the 'half') and that resembling a portion by the two diagonals is called pādyā (or the quarter) The description of the division of a rectangle or a square by diagonals is found in the Śulba primarily in connexion with the making of bricks of desired size and shape Pādyā are two kinds, viz dīrgha-pādyā (or longish or broader quarter) Śulapādyā (or trident quarter)[25] fig (1), fig (2), fig (3)



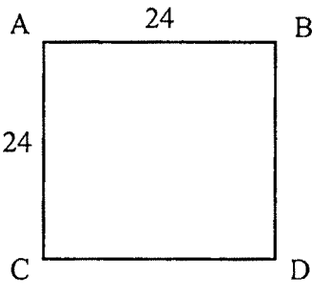
For example, to cover the fire-altar the following types of bricks have been prescribed [26]

B_1 → square brick of side $^1/_5$ pu, pañcami 24x24 sq ang

25 B Ś S iii 168,169,178 (or 14 5, 15 6)

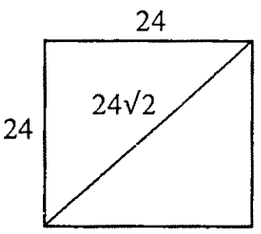
26 B Ś S 11 5-11 6

Indological Truths



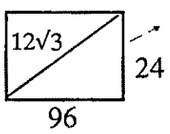
B_2 → triangular brick, half of one-fifth pañcami-pādyā

24, 24, 24√2 ang



B3 → triangular brick half of adhyardhā,

i e adhyardhārdha

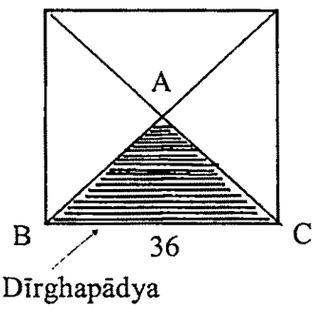


adhyardhārdha

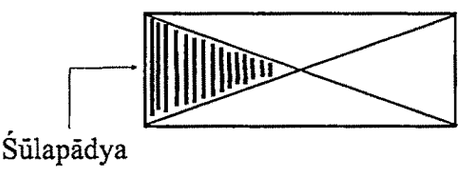
36, 24, 12*13 ang

B_4 → Quarter of adyardhā where

BC = 36 ang also called **dīrghapādya**



B_5 → triangular brick, quarter of adhyardhā with a short base BC=24 ang also called Śūlapādya



This implies that halves of a rectangle or a square by a diagonal are identical in size as well as in shape and the diagonals of a rectangle divide it into four parts which are equal in area, but they are of two kinds as regards their shape Since Śulbakāras classified as dīrgha-pādyā and Śūla-pādya we may conclude that Śulbakāras were aware that those separate two halves are identical

Another interesting kind of bricks formed by the combination of a half of a dīrgha-pādya or a 'Śulba-pāda' with another brick Baudhāyana describes

Indological Truths

"The right parts of them should be so combined as there will be a brick having three corners [27]

A brick of this kind is technically called "Ubhayī" because it is formed by the combination of two bricks of two different kinds

A triangular brick obtained by joining one-eighth of a pañcamī brick ABD with one-eighth of an adhyardhā brick ADC along the common side AD (=12 ang) becomes an ubhayī as shown in the fig (1)

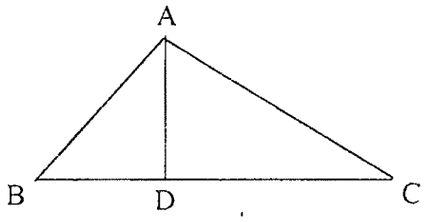
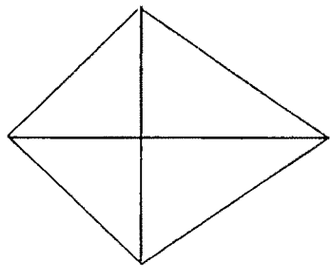


fig (1)

Sub-theorem

The diagonals of a rhombus bisect each other at right angles

A rhombus is called Ubhayatāh praugam[28] in Sulbasūtra While transformation of rhombus into a square, this theorem is applied In K S S (wishing to transform a rhombus into a square) it is (the rhombus) bisected by it transverse middle line and recombined as before [29] Eventhough, this theorem is just like the previous one it may be considered as a separate theorem since it is applied for the rhombus This theorem can be shown as in fig (2)



27 B S S III 122

28 B S S 1 57, M S S 10 3 6 4, ĀpS S 12 13, K S S IV-5

29 K S S 4 6

Indological Truths

Theorem 4 : As isosceles triangle divided into similar figures, a given square can also divided into small squares of equal areas.[30] It can be explained mathematically as follows:

ABCD is the given square, divide the sides AB, BC, CD and DA into X parts Join them Small squares of length $^1/_x$ the length are obtained in the fig (1)

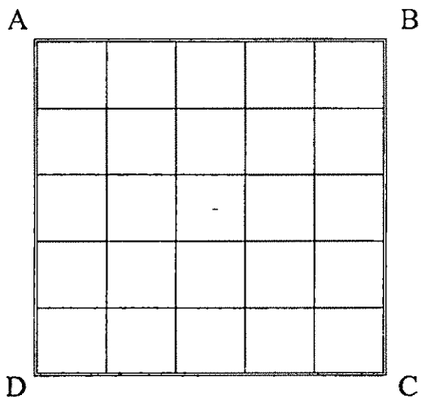
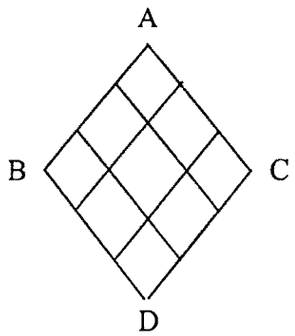


fig (1)

To divide a given rhombus into similar rhombus [31] If ABCD is a given rhombus, divide it into three rhombuses each of equal area so that we get $^1/_3$ area of that of the given rhombus



Baudhāyana also mentions the divisions of isosceles triangle in other two methods for getting the same figures The traditional practice in such a case was to divide each side into four equal parts and then to join the points of division two and two A triangle can be divided into a number of equal and similar parts by dividing

30 Āp Ś S 3 13 , K S S 3 7, 2-16-17

31 Āp Ś S 12 15, K Ś S 2 15-18

Indological Truths

the sides into an equal number of parts and joining the points of divisions two and two

In Bodhāyana, Āpastamba and Kātyāyana[32] this theorem mentioned Baudhāyana says- "one of the isosceles triangles (into which the entire fire-altar can be divided) is to be vertically bisected Each half is divided into 6 parts These two half isosceles triangles each divided into 6 parts) are to be placed on either side (the southern and northern side of the fire-altar)

Since the isosceles triangle ABC formed out of the square EBCD is $^{15}/_{2}$ sq pu we have,

BC=AF=√15 pu =120√5 ang =464 ang 22 ti (fig a)

The one-twelfth brick abc for the first layer has each of its two equal sides one-twelfth of AB and AC and the base one-twelfth of BC The half bricks are obtained by dividing abc vertically by af and the quarter bricks by joining the mid-points g, h, f of the three sides as shown in fig (b)

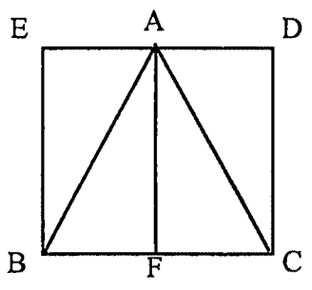
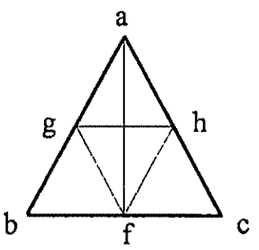


fig (1)



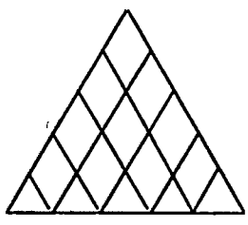


fig (2)

as indicated in the fig (a) Another method is by joining the vertex with the middle point of the opposite side Each of these has again been divided into six parts as shown in fig (b)

32 BŚS 14 1-8, ĀpŚS 12 4-6, KŚS 2 9

Indological Truths

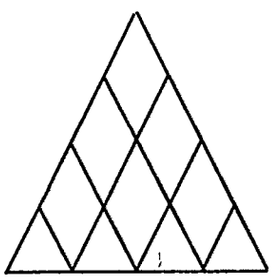


fig (a)

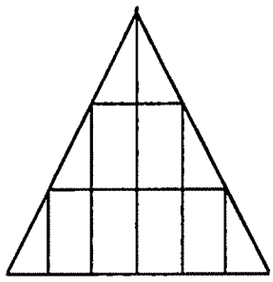


fig (b)

Theorem 5 : A straight line can be drawn at right angles to a given line:

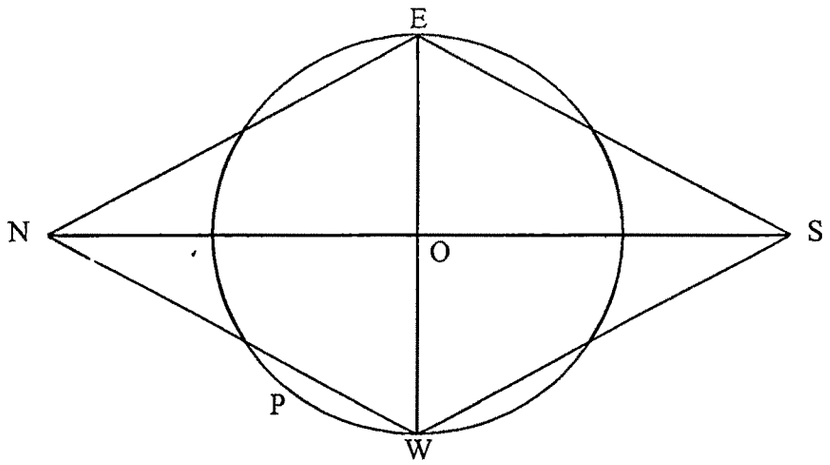
K Ś S [33] explains how to draw a east west line to a north south line There this theorem is applied-

"Two loops are fixed at the two ends of a cord Marks are at the śronīs, the amśas the nīrñchana and the samāsabhangas A pole is fixed at each end of the east-west line (of desired length), likewise (a pole is fixed at each of) the two śronīs (west corners) and the two aṃśas (east corners) Having fixed the loops at the two poles (on the east-west line), the cord is to be stretched by nirñchana mark towards the south-east corner The same is done towards the south-east corners The same is done towards the north-east corner After interchanging (the loops of the cord on the poles), the same is repeated This is the method (of construction of squares) and rectangles) in all cases " Using this method we can mathematically as follows

Let O be the pole, and circle EPW be drawn with a cord of length equal to OP Let E and W be the eastern and western shadow points on the equinoctial day of the fixed at O as shown in fig (1) Then EW is in east-west or prācī line Two knots are given at the two ends of a cord which is double of the original cord and are fastened at the poles at E and W The cord is then stretched towards north by its middle point and a mark N is given at it This is the north NS gives the north-south line In the Śulbasūtras the east-west line has always been drawn first, usually because of the importance attached to this direction By seeing the fig (1) we may conclude that a straight line can be drawn at right angle to the given line

33 K Ś S 1-3

Indological Truths



Theorem 6 : A quadrilateral formed by the lines joining the middle points of the sides of a rectangle is a rhombus whose area is half that of the rectangle.

This theorem is as that of the previous theorem [34] Only difference is instead of square, here it is rhombus It can be shown as in the fig (2)

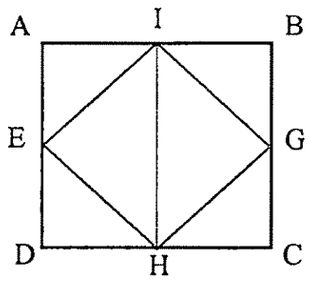


fig (2)

Theorem 7 : A parallelogram and a rectangle which are on the same base and within the same parallels are equal to one another.

This theorem may be shown as in the fig (1)

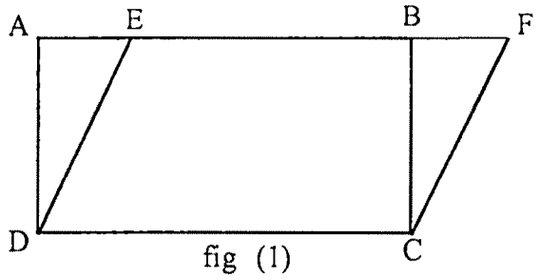


fig (1)

34 BŚS 2324, KŚS 34

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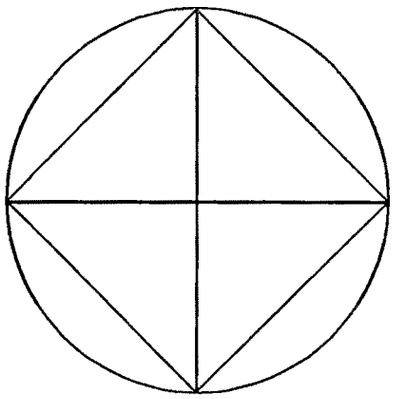
In the above figure, ABCD is a rectangle and DEFC is a parallelogram In Baudhāyana while transforming a rectangle into a square this theorem is applied [35] The assumption of the truth of this theorem forms the bases of the Śulba method of the construction of a parallelogram having given sides inclined at a given angle

Theorem 8 : The maximum square that can be described within a circle is the one which has its corners of the circumference of the circle:

In ĀŚS[36] this theorem is applied in the construction of a gārhapatya fire For a gārhapatya fire, a circular mound of earth is made and a pole fixed at the middle With this pole as a centre a circle is drawn with a radius equal to $^1/_2$ vyāyāma plus the extra (as per rule 3 2 for transforming a square into a circle) Within it (the circle) a square of the maximum size possible is drawn and divided into 9 parts



In the Śulba it is sometimes necessary to draw within a circle "a square as large as possible" (yāvat saṃbhavet) "but it is not indicated how to do it From the subsequent descriptions it, In fact, two diametres of the circle are drawn at right angles to each other The figure formed by joining the end points of them, is the largest possible square within the circle

35 B Ś S 1-54 (or 2-5)

36 Ā Ś S vii-10 (7-5)

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Theorem 9 : The square on the hypotenuse of a right angled triangle is equal to the sum of the squares on the other two sides:

This theorem was explained elaborately in the chapter 6 (page no) Therefore, it is unnecessary to explain again now

Conclusion:

Thus Śulbasūtrakāras know the problems relating to rectlinear figures, their combinations and transformations and even the theorems or rules behind the various constructions

□

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Conclusion

"Śulbasūtras : A Critical Analysis" has a special importance, because this subject involves rules of construction of altars for sacrifices, rules of modern geometry, rules of Engineering materials, rules of architectural designs and rules of statistics It is really a wonder that, with such simple instruments like 'cord' and 'peg' they have designed wonderful drawings with perfect calculations from 800 B C to 200 B C This is the main contribution of Śulbasūtras

The Critical analysis of Śulbasūtra is a very rare study Knowledge of ancient times requires insight in Vedic sacrificial scriptures and modern branches of sciences like physics mathematics including astronomy Comparing and analysing of four Śulbasūtras viz , Baudhāyana, Āpastamba, Kātyāyana and Mānava contribute to indepth study in this field The texts which I have given in the appendix of the thesis is of very rare kind, a ready reckoner for the scholars This type of serious study on Śulbasūtras was not conducted before This is to sythesise both traditional view and mathematical view and their applications so as to make them relevent The scholars had not taken serious note on this subject because these texts are not popular and need inter-disciplinary study

Further, the texts are written in the "sūtra" i e , (aphoristic style) which is technical in nature to understand There were several technical terms (many of them I listed in the appendix with meanings) to be properly understood, before one goes to comment upon them. To understand the matter properly the knowledge of geometry is very much essential

I am a B Sc graduate with mathematics as optional subject of studies and a post-graduate degree holder in Sanskrit This background of my literacy helped much in research study of Śulbasūtras and to understand it properly I have analysed them from the traditional point of view and from the modern view I have assimilated several scientists' proofs for some rules of Śulbasūtras and added my own

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interpretations The tables, drawings, diagrams would help in understanding the topics easily

The contributions of Śulbasūtras to the history of Indian scientific thought and development of knowledge must be considerable, especially in the field of mathematics and technology The learned scholars should not ignore the actual thoughts of Śulbasūtras and I feel that in these rules can also be applied in the field of modern mathematics It is our duty to create awareness on the Śulbasūtras among young students who study science form their secondary school level till graduation

Observations and Findings in the thesis:

The critical and analytical study of Śulbasūtras conducted by me with the objective of study of ancient rare system of knowledge found in our scriptures in the form of sūtras, on the basis of interdisciplinary methods Now my study of these Śulbasūtras, their methodology, simplicity in application, usage of instruments, calculation methods etc convinced me that it has, its relevance and advantages (benefits) to the field of Engineering The narration of these sūtras are very much akin to Modern Mathematic Approach

Important findings which I have observed in my study have been enlisted here as the conclusion of my thesis

1 The Śulbasūtras have special importance because, these involve several geometrical applications and problems relating to rectilinear figures, their combinations and transformations as well as arithmatic and algebric calculations Hence Śulbasūtras may be considered as the earliest books of Mathematics especially "Analytical geometry"

2 The word 'Śulba' itself means 'to measure' and 'Śulbavid' means that one who is an expert in measurement and calculation Thus Śulba is a technical word and it has special significance

Indological Truths

3 The layouts for different sacrifices and the constructions of fire-altars involve several procedures like-selection of site by surveying Cleaning and levelling, planning and marking, digging and construction of *Vedi, Citi* etc These procedures are technically same manner similar to that of that of the procedures of the construction of a building

4 Geometricians or Engineers design any structure with the help of highly sophisticated instruments or mathematical compass, but Śulbasūtras have designed complicated structures with only simple instruments like 'cord', peg etc

5 The traditional-orthodox scholars consider these Śulbasūtras as the manuals for the constructions of the various sacrificial fires and altars only They do not bother about the geometry or technology much and they have simply taken as it utilitarian material required for the layout of different constituent parts of the sacrifices They might have felt that it was not relevant to them Whatever was relevant for them relevant at that time also has a relevance in modern age

6 Modern mathematicians or engineers most of the times, are not interested in the serious study of ancient Sanskrit literature like Śulbasūtras in a scientific view Sometimes, it is very difficult to guess how the Śulbasūtras derived several mathematical rules in those days

7 There are many methametical theorems as mentioned before in Śulbasūtras which can be compared with modern methametical theorems Predominently, to mention here theorem which we call Pythagoras theorem is already mentioned in Śulbasūtras as Bhuja-koṭi karna nyāya In fact this theorem should be named as the theorem of Bodhāyana because the date of Bodhāyana belonged to an age which as much earlier to Pythagoras (i e 540 B C)

8 The value of $\sqrt{2}$ according to Śulbasūtras was $\sqrt{2}=1+{}^{1}/_{3}\,4 - {}^{1}/_{3}\,4\,34$, turned into

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decimal fraction gives 1 414215683 According to modern calculation $\sqrt{2}$=1 41421356 Thus the value of $\sqrt{2}$ is correct upto five decimals

9 The value of π known to Śulbasūtras was 3 008 and the modern value is 3 14 Thus there is no much difference in the value of π also Surprisingly this have been generated in an age where people lacked any kind of sophistications On the contrary, they gave more importance to religious rituals

10 The various steps like, the specifications for the bricks, the fabrication of bricks and the specifications for the construction of a Citi are followed similarly even in these modern days especially in preparation of bricks and in the construction using the bricks

Thus the study of Śulbasūtras made me feel satisfied to certain extent that a bird's eye-view of the vast and deep treasure-house of ancient spiritual science which never becomes empty for those who have right perspective with rational analytical approach

□

Indological Truths

Appendix I

Table - 1

Classification of Vedic Schools

		यजुर्वेद			
वेद	ऋग्वेद	कृष्ण	शुक्ल	सामवेद	अथर्ववेद
शाखा	१) शाकल २) बाष्कल ३) सांख्यायन ४) आश्वलाय ५) माण्डूक्य ६) कौषीतकी	१) तैत्तिरीय २) मैत्रायणी ३) काठक ४) कपिस्थल	१) माध्यन्दिन २) काण्व (वाजसनेयी)	१) कौथुम २) जैमिनीयकिंवा तलवकार	१) शौनक २) पिप्पलाद
ब्राह्मण	१) ऐतरेय ३) सांख्यायन ६) कौषीतकी	१) तैत्तिरीय २) मैत्रायणी ३) काठक ४) कपिस्थल -कठ	१) शतपथ	१) तांड्य किंवा पञ्चविंश, षड्विंश, आर्षेय इत्यादि ३) जैमिनीय	१) गोपथ
आरण्यक	१) ऐतरेय ३) सांख्यायन	१) तैत्तिरीय ४) कपिस्थल -कठ	१)बृहदारण्यक	१) आरण्यक संहिता २) आरण्यक गान २) जैमिनीय	--
श्रौतसूत्रे	३) सांख्यायन ४) आश्वलायन	१) बौधायन, भारद्वाज आपस्तम्ब, सत्याषाढ हिरण्यकशी, वाधुल, वैखानस २) मानव अथवा मैत्रायणी किंवा मानव -मैत्रायणी ३) काठक, (फुटकळ)	१) कात्यायन	१) लाट्यायन, आर्षेयकल्प, निदानसूत्रे २) द्राह्यायण ३) जैमिनीय	१) वैतान
शुल्बसूत्रे	--	१) बौधायन, आपस्तम्ब सत्याषाढ,वाधुल २) मानव, मैत्रायणी,वराह	१) कात्यायन	--	--

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Table - 2

शुल्बसूत्र	टीका	टीकाकार
बौधायन	शुल्बदीपिका शुल्बमीमांसा	द्वारकानाथ यज्व व्यकटेश्वर दीक्षित
आपस्तम्ब.	शुल्बव्याख्या शुल्बप्रदीपिका शुल्बप्रदीप	कपर्दिस्वामी करविन्दस्वामी सुन्दरराज माधव
मानव	--	शिवदास
कात्यायन	-- शुल्बसूत्रवृत्ति शुल्बसूत्रविवरण -- -- --	कर्क रामचंद्र वाजपेयी महीधर सोमसुत गंगाधर पाठक विद्याधर गौड

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Table - 3

Ice Age to the Great Drought

Sl. No.	Date	Geography/Climate	Periods/Events/Literature
1.	B.C. 9000	Ice age	
2.	B.C. 8000	Ice melts	
3.	B.C. 4000		Early Vedic period : RRg Veda
4.	B.C. 3750		The closing of the RRg Veda age with third and seventh maṇḍalas. Age of Vasiṣṭha and Viśvaamitra. The Battle of Ten Kings (c. 3730 B.C.)
5.	B.C. 3500	Sarasvati Perennial	Silver, (Kunaal) purification of copper.
		6. B.C. 3100	Sarasvati loses Yamuna Post Vedic period. Kaliyuga Mahabharata war canonization of the Vedas by Vyasa and his school.
7.	B.C. 300	Desert	The Suutra Braahmaṇa period
		Expands flooding	Harappa, Mohinjodaro, Śatapatha Braahmaṇa, Śulbasūtras.
8.	B.C. 2200	Major drought begins	Decline of Harappa
9.	B.C. 2000	Sarasvati loses Sutlej	End of Suutric period
10.	B.C. 1900	Sarasvati Dry	End of Vedic age or Harappa Great Drought.

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Table - 4

1	Indus Valley Mathematics	C 2300 B C -1700 B C
2	Mathematics in the Age of Vedas	C 2000 B C -800 B C
3	The Age of the Vedāngas or the sūtra period	C 800 B C -200 B C
4	Buddhist and Jain Schools	C 600 B C -300 A D
5	Pre classical age of epics and Siddāntas	C 200 B C -320 A D
6	The Classical period (The Golden age of Indian Mathematics)	A D 320 - 750 A D
7	From New Jain Writings to Bhāskara II	A D 750 - 1200 A D
8	Medieval mathematics in North India	A D 1200 B C -1850 A D
9	The Late Āryabhaṭīya School	A D 1400 - 1850
10	From the founding of the Universities to Freedom	A D 1857 - 1947

Indological Truths

Table 5

Units of length measures given in different treatises of Silpaśāstra

Unit	Vāstuvidyā CH.1	Visvakarma Vāstsātra CH.7	Samarangana Sūtradhāra	Kāsyapasilpa Patala 23	Mānasāra CH.2	Śilparatna CH 2	Isānasiva-Gurudeva-Paddhati Patala 5.
8 Paramāṇus	1Rathareṇu	-----	1Reṇu	----	1Rathadhūli	1Trasrenū	1Raja
8Rathareṇus	1Vālāgra	----	1Vālāgra	1Keśāgra	1Vālāgra	1Vālāgra	1Kaca
8Vālāgras	1Likśā	----	1Likśā	-----	1Likśā	1Liksā	1Liksā
8 Likśās	1Yūkā	-----	1Yūkā	-----	1Yūkā	1Jūkā	1Yūkā
8 Yūkās	1Yava	------	1Yavamadha	1Yava	1Yava	1Yava	1Yava
8 Yavas	1 Angula	---	1large Angula	1large Angula	1large Angula	1large Angula	1large Angula
7 Yavas	-----	----	1middium	1middium	1small Angula	1middium	---
			Angula	Angula	Angula	Angula	----
6 Yavas	----	-----	1small Angula	1small Angula	1small Angula	1small Angula	-----
4Vrihis	---	---	---	1large Angula	1large Angula	----	-----
3 Vrihis	-----	1 Angula	---	1small Angula	1 middium,,	----	----
1½ Vrihis	----	----	-----	-----	1smallar,,	---	----
12 Angula	1Vitasti	1Vitasti	1Vitasti	-----	1Vitasti	1Vitasti	1Vitasti
24 Angula	1Hasta or 1Kisku	1Hasta	1Hasta, 1Aratni	1Krsna Hasta	1Kisku	1Hasta 1Kisku	1Hasta 1Kisku
84 Angula	---	Dhanurmuṣṭi	1Yyama, 1Purusa	--	---	----	----
96 Angula	-----	1Danda	1Yuga 1Cāpa 1Nādi	1 Danda	---	1 Danda	1 Danda 1Dhanu-sya

Indological Truths

Table 6

Unit	Baudhāyana		Mānava		Āpastamba		Kātyāyana	
	Relation	Sūtra No.	Relation	Sūtra No.	Relation	Sūtra No.	Relation	S N
1Angula	14Anu 34grains of sesamum	1 4 1.5						
1Kśudrapāda	10Angulas	1.6	10Angulas	10 1 4.4	12Angulas	15.13		
1Prādeśa	12Angulas	1.7	12Angulas	10 3 22				
1Prtha		1.8						
1Uttarayuga	13Angulas							
1Pāda		1.8						
1Aratni		1.9	12Angulas	10.3.2 7		6 23	12Angulas	5
	13Angulas	1 16		10.1 4.4	15Angulas	11 5		5
	15Angulas				24Angulas		24Angulas	
	24Angulas		24Angulas					
1Prakrama	30Angulas	1.15	24Angulas	10.1.12 3	30or 45Angulas	6.2.3		
1Jānu	32Angulas	1 13	30Angulas	10.3.1 3	32Angulas	10 18		
1śamyā	36Angulas	1.14			36Angulas	6 22	32Angulas	2
1Bāhu	36Angulas	1.14	42Angulas	10.3 3 6				
1Purusa	120Angulas	1.19	120Angulas	10.1.4.5	120Angulas	15 10	120Angulas	5
1Vyāma	120Angulas	1 20						
1Vyāyāma	96Angulas	1.21	96Angulas	10.1.4 4	96Angulas	15 11		

Indological Truths

Table 7

Units of length measures given in Śulbasutras

Unit	Baudhāyana		Mānara		Āpastamba		Kātyāyana	
	Relation	Sūtra No.	Relation	Sūtra No.	Relation	Sūtra No.	Relation	Sūtra No
1Angula	14Aṇu 34grams of sesamum	1.4 1 5						
1Virāt	150Angulas	1 78						
1Iṣā	188Angulas	1.10	188Angulas	10.1.2.1	188Angulas	6.13	188Angulas	2.2
1Akśā	104Angulas	1.11	104Angulas	10.1.2.1	104Angulas	6 13	104Angulas	2.3
1Yuga	86Angulas	1.12	86Angulas	10.1.2.1	86Angulas	6 13	86Angulas	2 4
1Anūka					30Angulas	11.4		
1ūrvasthi					20Angulas	11.6		
1Nābhi					64Angulas	10 19		
1Āsya					96Angulas	10.20		5 9
1Vitas 1śaya 1Ārva			12Angulas 96Aṅgulas 6 Angulas	10.1.4.4 10.1.4.4 10.3.1.3			12Angulas	
1Pisila					12Angulas	7 18		

Indological Truths

AREAS OF *PRĀGVAMŚA, MĀHĀVEDI, SADAS*, ETC., THEIR RELATIVE DISTANCES; CONSTRUCTION OF *EKĀDAŚI* AND *AŚVAMEDHA VEDI*, AND THE VALUE OF π

4.1-4.11. The areas of different chambers and *vedis* as given by Baudhāyana are tabulated below :

Name of altar	*Geometrical shape*	*Measurement*
āgnidhṛiya	square	side = 5 *aratnis.*
cātvāla	square	side = 36 *aṅgulas.*
dhiṣṇas	circle	diameter = 2 *prādeśas.*
havirdhāna	square	side = 10 or 12 *prakramas.*
mahāvedi	isosceles trapezium	face = 24 *padas*, base = 30 *padas*, altitude = 36 *padas*,; the units may be also in *prakramas.*
mārjāliya	square	side = 5 *aratnis.*
prāgvaṃśa	rectangle	length = 16 *prakramas*, breadth = 12 *prakramas*; or length = 12 *prakramas*, breadth = 10 *prakramas.*
sadas	rectangle	length = 27 *aratnis*, breadth = 10 *prakramas* ; or length = 18 *aratnis*, breadth = 10 *prakramas.*

Indological Truths

Table 9

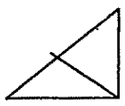
Name of the fire alter	Information of Bricks						
	Shape	Dimensions (Angula)	Area (sq Anguala)	I layer		II layer	
				No of bricks	Area (sq Angula)	No of bricks	Area (sq Angula)
Gārhapatya (2 64)	Rectangular	32*13 71	438 85696	21	9215 99616	21	9215 99616
Gārhapatya (2 67)	Square	16*16 24*24 32*32	256.0 576.0 1024 0	9 12	2304 0 6912 0	16 5	4096 0 5120 0
					9216 0		9216 0
Caturasra śyena citi Type 1 (3 24-32)	Square Caturthī pañcamī sasthī Daśamī	30*30 24*24 20*20 12*12	900 0 576 0 400 0 144 0	24 120 36 20 200	21600 69120 14400 2880 1,08,000	12 125 63 200	10800 72000 25200 1,08,000
Caturasra śyena citi Type 2 (3 47-54)	Square Pañcamī Pādyā Rectangular Ardhyā Adhyardhā	24*24 12*12 12*24 36*24	576 0 144 0 288 0 864 0	160 2 30 8 200	92160 288 8640 6912 1,08,000	165 4 25 6 200	95040 576 7200 5184 1,08,000
śyena citi (bird shaped) Type 1 (4 2-7)	Squre Triangular Ardhyā	30*30 30 36 30	900 450	69 72	62100 32400	68 70	61200 31500
	Pādyā	21-7*21-7 21-7 * 30	225	52	11700	56	12600

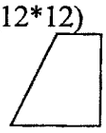
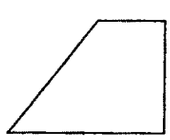
Indological Truths

	Hamsamukhī	7 ½ * 21-7 21-7 * 22 ½	450	1	450	6	2700
	Caturasra Pādyā	22 ½ *15 15 *7 ½	225	6 200	1350 1,08,000	200	1,08,000

Name of the fire alter	Information of Bricks						
	Shape	Dimensions (Angula)	Area (sq Anguala)	I layer		II layer	
				No of bricks	Area (sq Angula)	No of bricks	Area (sq Angula)
śyena citi (bird shaped) Type 2 (4 45-61)	Square Pañcamī Rectangular	24*24	576	54	31104	11	6336
	Adhyardhā	36*24	864	40	34560	67	57888
	Sapādā	30*24	720	2	1440	21	15120
	Triangular Ardhyā	26 *36 36 * 43-9	288	28	8064	12	3456
	Pādyā	12 * 12	144	---	----	11	1584
	Ardhyā of Adhyardhā		432	76	32832	34	14688

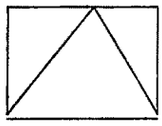
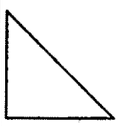
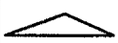
Indological Truths

	Dīrhapādyā Adhyardhā		216	----	-----	28	6048
	śūlapādyā of Adhyardhā		216	-----	----	6	1296
	Aṣṭamī		72	----	-----	2	144
	Ubhayī		180	200	1,08,000	8 200	1440 1,08,000

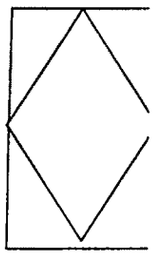
Name of the fire alter	Information of Bricks						
	Shape	Dimensions (Angula)	Area (sq Anguala)	I layer		II layer	
				No of bricks	Area (sq Angula)	No of bricks	Area (sq Angula)
Kanka cıtı (4 86-89)	Square Pañcamī Trıangular Ardhyā Pādyā Astamī Trapızıum Pāda Adhyardhā	24*24 ½(24*24) ½(16-32*16-32) ½(12*12)  	576 288 144 72 144 864	106 44 8 4 ---- 38 200	61056 12672 1152 268 --- 32832 1,08,000	36 24 48 4 4 84 200	20736 6912 6912 288 576 72576 1,08,00
Alaja cıtı (4 92-99)	Square Pañcamī Trıangular	24*24	576	118	67968	54	31104

Indological Truths

	Ardhyā Pāda Trapizium Adhyardhā	 ½(24*24) ½(16-32*16-32) As given above	 208 144 864	 52 2 28 200	 14976 288 24192 1,07,424	 14 54 78 200	 4032 7776 67392 1,10,304

Name of the fire alter	**Information of Bricks**								Remark
	Shape		Dimensions (Angula)	Area (sq Anguala)	I layer		II layer		
					No of bricks	Area of bricks (sq Angua)	No of bricks	Area o bricks (sq Angu	
Prauga cıtı (4 100-110)	Rectangular Brhatī		38 72983*19	36491 749 99967 88 65999 97096	114	85499 96283			
Triangular Ardhyā			374 99983	112	41999 98096	34	12749 99422		AreaABCD =2*1,08,000 (sq Angula)
Dīrghapādyā			187 49991	----	-----	2	374 99982		AB=464 758 Angula
śūlapādy ā			187 49991	--- 200	--- 1,07,999 95192	50 200	9374 99550 1,07,999 95273		½ AB= 138 72983

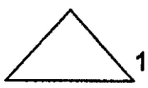
Indological Truths

Name of the fire alter	Information of Bricks						
	Shape	Dimensions (Angula)	Area (sq Anguala)	I layer		II layer	
				No of bricks	Area (sq Angula)	No of bricks	Area (sq Angula)
Ubhayatah	Rectangular	36 51483*18 25741	666 66622	124	82666 61128	128	85333 27616
Prauga citi (4 111-117)	Brhatī						
	Triangular Ardhyā		333 33311	76	25333 31636	64	21333 31904
							

AC=657 26706

CD=328 63353

=FD

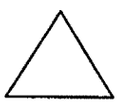
Dīrghapādyā  166 66655 --- --- 4 666 66620

1/18 CD

=18 25741

1/18 AC

=36 51483

Śūlapādyā  166 66655 ---- ---- 4 666 66620

---- ---------- --- ----------

200 1, 07,999 92764 200 1, 07,999 92760

Drona citi (Square) (605-22)	Square sasthī	20*20	400	12	800	19	7600
	Caturthī	30*30	900	---	----	22	19800
	Rectangular Adhyardhā	30*20	600	164	98400	122	73200

Indological Truths

	Ardhyā	20*10	200	24	4800	37	7400
				200	1, 08,000	200	1, 08,000
Drona cıtı (Cırcular)	Square	21 75837*21 75837	437 42666	168	79535 67888	168	79535 67888
(7 1-11)		Area of remaınıng brıcks		32	28464 32112	32	28464 32112
			Total	200	1,08,000 00	200	1,08,00 000

Note –Area of Drona cıtı = 1, 08,000 Sq Angulas

One brıck of area of 900 Sq Angula ıs removed

Area of the cırcle = 107100 Sq Angulas, Radıus of Cırcle = 184 62548A

The length of the sıde of a squre cırcumscrıbed by Thıs cırcle = 261 10051A

The length of the sıde of a brıck = 861 10051

---- -- ----

12

= 21 75837A

Name of thefire alter	**Information of Bricks**						
	Shape	Dımensıons (Angula)	Area (sq Anguala)	I layer		II layer	
				No of brıcks	Area (sq Ang ula)	No of brıcks	Area (sq Angula)

Rathacakra Cıtı (Pradhı-Yukta) type 1 one sıde (5 1-8) Curvılınear

square of dıfferent shapes wıth

21 85104*21 85104 477 46794

168	80214 61392	168	80214 61392
32	27785 38608	32	27785 38608
200	1, 08, 00000	200	1, 08,000 00

the area of the cırcle = 1, 08, 0005/A

The radıus of the cırcle = 185 41176A

The lengh of the sıde of the square cırcumscrıbed by thıs Circle = 262 21248A

The length of sıde of a brıck = 26221248

Indological Truths

---------- = 21 85104A

12

Rathacakra Cıtı (Sārā) Type 2 (5 9-36)	Brıcks ın nābhı	900	8	7680	
	Brıcks ın nemī	543 75	128	69600	
	Brıcks ın arā	480 0	64	30720	
			200	1,08,000	
	Brıcks ın nābhı	540 00001		8	4320 00008
	Brıcks ın nemī	480 00023		64	30720 01524
	Brıcks ın Arā	647 99987		80	51839 98964
	Brıcks near Nemī	607 5		32	19439 99350
	Brıcks ın nābhı	104 9996		16	1679 99935
					107,999 99799

Indological Truths

Table 10

GEOMETRICAL TERMS USED IN BAUDHĀYANA ŚULBASŪTRAS

Amsa	The North-East and South- East corner of a Vedi (I 34)
Amhīyas	Small in length(I 45)
Aksnayā	Hypotenuse (I 45)
Aksnayā Rajju	Cord lying on Hypotenuse (I 45)
Animat	Small(I 55)
Animatah Karanī	Smaller side (of a rectilinear figure) (I 55)
Atiśisa	Remaining(I 58)
Anitya	Approximate (I 60)
Anīka	Side, line (3 57)
Anūci	In contact with each other (I 67)
Anta	end (I 23)
Antaratah	from inside, inside a given side (5 30)
Antarāla	Distance between two given places (3 59)
Antahspandyam	Space surrounded by cord (4 21)
Anvāyacchet	to stretch (4 96)
Apacchid	to remove, to subtract (I 56)
Apanāmah	bend(of the wing ofabird) (4 53)
Apara	West direction or behind (towards western side) of a given object (9 15)
Apara Dakśinam	South –West direction (6 14)
Aparikarsana	The difference of radius of two concentric circles (5 32)
Aparimita	A figure obtained by adding one unit in the given quantity (I 99-Dvādaśa Dīkśā Dīkśā Aparimitāvā, here Aparimita means thirteen)
Apāyamya	to stretch (a cord) (I 35)
Abhitah	on both sides (of a given object) (I 37)
Abhayapātayet	to place on (prāci) (I 58)
Ardha	half (I 34)
Avaśisya	to leave as a remainder (I 97)
Āgantukam	the one obtained (I 68)
Ādadīta	to add (I 107)
Āyāma	length (longitudinal side) (I 88)
Ālikhya	to draw a line (I 22)

Indological Truths

Āvāpa	added (5 23)
Āvāpena	by adding (I 54)
Itaratra	(to place) in other position (I 55)
Uttara	North direction , on the left side (of a given object) (I 28)
Uttaratah	towards North (I 28)
Uttarottara	further and further (2 4)
Udak	(from South) to North (I 94)
Uddharet	to subtract (I 59)
Uddhrtā	subtracted(4 97)
Unnayet	to lengthen (9 11)
Upadadhyāt	to place (8 9)
Upara	bottom (1 113)
Uparistāt	on top of (1 39)
Upalabdhi	Proof(1 49)
Upasamharet	to remove, to subtract (1 51)
Upādhāna	(while) placing (the brick) (3 24)
Ubhayatah	(at) both (ends) (1 22)
Ubhayatah Prauga	Rhombus (1 57)
Ullikhet	to subtract (1 51)
Ūna	less (1 32)
Ūrdhvapramāna	measure of height (2 13)
Rjulekhā	straight line (2 13)
Kanīyas	smaller (1 50)
Karanī	side (of a rectilinear figure) (1 55)
Krtānta	the end (or side) of a (drawn figure) (2 10)
Khanda	a piece (1 54)
Catuhsraktih	a rectilinear figure with four sides (1 79)
Caturasra	a rectilinear figure with four sides but generally a square (1 22)
Caturasra Karanī	the side of a square (1 60)
Caturbhāgīyā	a square (brick)with sides of length equal to one –fourth purusa (4 35)
Cikīrsan	to wish (1 22)
Cinvīta	to construct (brick masonry) (2 18)

Indological Truths

Jaghana	rear part of a given object (3 52)
Jyāyas	larger (2 18)
Tāvatīm	that much (1 38)
Tiryak	width (1 46)
Tiryanmānī	the side giving width of a rectilinear figure) (1 48)
Trtīya karanī	The side of a square the area of which is one- third of that of a given square (1 47)
Trikaranī	The side of a square the area of which is thrice of that of a given square (1 46)
Daksina	South direction ,on the right side (of a given object) (1 28)
Daksināvrtalekhā	line turning clock wise (2 30)
Dadhyāt	to place(1 109)
Dīrgha karanī	Longitudinal side of a rectangle (1 87)
Dirghacaturasra	rectangle (1 36)
Drāghiyān	to increase, to lengthen (3 19)
Dvikaranī	the side of a square whose area is twice that of the given square (1 46)
Dviguna	twice (1 30)
Nirastam	subtracted (1 51)
Nirjihīrsan	(if) subtraction is intended (1 51)
Nirnāmah	bend (of the wing of a bird) (4 22)
Nirharet	to locate (1 44)
Nirhārah	the subtraction (1 54)
Nemi	felli (of a charriot) (5 21)
Nyañcana	the mark on a cord required to construct a right angle
Prthu	wide (1 5)
Pramāna	measure (1 3)
Pañcamabhāgīyā	a square brick having sides of length equal to one fifth of a purusa (24 angula long) (3 31)
Parasmin	of western part (1 42)
Parināha	perimeter (1 113)
Parimāna	mensuration (1 2)
Parilikhet	to draw (a circle) (1 23)
Paścāt	rear (1 28)
Paścāt Tiraścī	rear cross line(1 76)

Indological Truths

Pārśva	nearby (2 25)
Pārśvamānī	longitudinal side of a rectilinear figure (1 48)
Pāsa	knot (1 24)
Purastāt	in front of (Eastward) (1 41)
Pūrayet	to complete (8 13)
Pūrva	the east direction (1 27)
Pūrvāpara	the eastern and western side (3 29)
Prauga	isosceles triangle (1 56)
Pradhi	a rectangle with circular curve as one of its sides(when the largest square is fitted in a given circle the the remaining parts of a circle are called Pradhi) (2 71)
Prācī	an east-west centre line (of a given figure) (1 31)
Bahispandyam	outside the cord (1 56)
Bhūmi	area (1 36)
Manala	a circle (1 23)
Madhya	centre point (1 22)
Mānayoga	measure, measurement (1 96)
Yāvatī	as much as (1 38)
Rajju	a cord (1 22)
Rhāsa-vrddhi	more or less (8 17)
Laksana	a mark (1 22)
Lekhā	a line (1 22)
Vardhayet	to extend (1 61)
Varsīyasah	Larger (in length, area etc) (1 50)
Vitrtīyā	one-third (1 81)
Vidhā	(so many) times (24)
Vidhābhyāsa	to extend by (so many) times (2 4)
Viparyasya	to reverse (1 55)
Vidhajet	to divide (2 64)
Vimimīta	to measure, to take measurements (1 107)
Viskamhānta	the two extremes of the diameter (1 23)
Vrdhra	to extend, to increase (1 50)
Vyāsa	width (1 88)

Indological Truths

śesa	remainder(1 55)
śronī	the westward corner (NW and SW corners) of a rectilinear figure (1 35)
Samślista	adjoining (1 5)
Samsargah	(where two lines) cross (each other) (1 28)
Samacaturasra	a square (1 52)
Samasyan	in order to make a sum (of two areas) (1 50)
Sameyātām	(where it) meets (1 25)
Sambhujya	(by) dividing (1 68)
Savišesa	the ratio of the length of diagonal to that of the side of a square (1 62)
Savyāvrtalekhā	a line turning anticlockwise (2 31)
Sraktih	angle (2 25)

GEOMETRICAL TERMS IN ĀPASTAMBA ŚULBA SŪTRAS
(Other than Baudhayana)

Atiśaya	the length beyond the given boundary (3 2)
Uparı-uparı	again and again (9 1)
Kotī	half the hypotenuse (3 2)
Cchedam	to cut (5 18)
Lekhāṣamaram	the point of crossing of arcs (9 1)
Sa samādhih	it is achieved (1 5)
Sannata	narrow (4,10)

GEOMETRICAL TERMS IN MĀNAVA ŚULBA SŪTRAS
(Other than B.ś.Ṣ and Ā.ś.S.)

Adhyardha	having an additional half (10 1 2 4)
Āgama	increased length of a cord (10 1 1 11)
Aṃsa	Apart or portion of a rectangle (10 1 1 5)
Ghana	cube (10 3 1 9)
Prsthyā	centre line of rectilinear figure (10 1 1 2)
Mītvā	to measure (10 1 1 4)
Trinkunta	Triangle (10 3 2 12)
Raśi	Multiplication (10 3 1 9)
Viśkambha	the diameter (10 3 6 15)

Indological Truths

Appendix II

Baudhayana Śulbasūtram

1

1 1 आत्मेऽग्निचयाः । (I 1)

1 2 तेषां भूमेः परिमाणविहारान् व्याख्यास्यामः । (I 2)

1 3 अथाङ्गुलप्रमाणम् । (I 3), चतुर्दशाणवः । (I 4), चतुस्त्रिंशत्तिलाः पृथुसम्मिष्टा इत्यपरम् । (I 5), दशाङ्गुलं क्षुद्रपदम् । (I 6), द्वादश प्रादेशः । (I 7), पृथोत्तरयुगे त्रयोदशिके । (I 8), पद पञ्चदश । (I 9), अष्टाशीतिशतमीषा । (I 10), चतुःशतमक्षः । (I 11), षडशीतिर्युगम् । (1 12), द्वात्रिंशज्जानुः । (I 13), षट्त्रिंशच्छम्याबाहू । (I 14), द्विपदः प्रक्रमः । (I 15), द्वौ प्रादेशावारत्निः । (I 16), अथाप्युदाहरन्ति । (I 17), पदे युगे प्रक्रमेऽरात्नावियति शम्यायां च मानार्थेषु याथाकाम्मीति । (I 18), पञ्चारत्निः पुरुषो । (I 19), व्यामश्च । (I 20), चतुरत्निर्व्यायामः । (I 21)

1 4 चतुरस्रं चिकीर्षन्यावच्चिकीर्षेत्तावतिं रज्जुमुभयतः पाशं कृत्वा मध्ये लक्षण करोति । लेखामालिख्या । (I 22), तस्या मध्ये शङ्कं निहन्यात् । तस्मिन्पाशौ प्रतिमुच्य लक्षणेन मण्डल परिलिखेत् । विष्कम्भान्तयः शङ्कू निहन्यात् । (I 23), पूर्वस्मिन्पाश प्रतिमुच्य पाशेन मण्डल परिलिखेत् । (I 24), एवमपरस्मिंस्ते यत्र समेयाता तेन द्वितीयं विष्कम्भमायच्चेत् । (I 25), विष्कम्भान्तयः शङ्कू निहन्यात् । (I 26), पूर्वस्मिन्पाशौ प्रतिमुच्य लक्षणेन मण्डल परिलिखेत् । (I 27), एवं दक्षिणत एवं पश्चादेवमुत्तरातास्तेषां येऽन्त्याः संसर्गस्तच्चतुरस्रं सम्पद्यते । (I 28)

1 5 अथापरम् । (I 29), प्रमाणाद्द्विगुणं रज्जुमुभयतः पाशां कृत्वा मध्ये लक्षणं करोति । (I 30), सा प्राच्यर्थः । (I 31), अपरस्मिन्नर्धे चतुर्भागोने लक्षणं करोति । (I 32), तन्यञ्चनम् । (I 33), अर्धेऽशार्थम् । (I 34), पृष्ठ्यान्तयोः पाशौ प्रतिमुच्य न्यञ्चनेन दक्षिणापायम्यार्धेन श्रोण्यंसान्निर्हरेत् । (I 35)

1 6 दीर्घचतुरस्रं चिकीर्षन्यावच्चिकीर्षेत्तावत्या भूम्यां द्वौ शङ्कू निहन्यात् । (I 36), द्वौ द्वावेकैकमभितः समौ । (I 37), यावती तिर्यङ्मनी तावती रज्जुमुभयतः पाशं कृत्वा मध्ये लक्षणं करोति । पूर्वेषामन्त्ययोः पाशौ प्रतिमुच्य लक्षणेन दक्षिणापायम्य लक्षणे लक्षण करोति । (I 38), मध्यमे पाशौ प्रतिमुच्य लक्षणस्योपरिष्टाद्दक्षिणापायाम्य लक्षणे शङ्कुं निहन्यात् । (I 39), सोऽश एतेनोत्तरोऽशो व्याख्यातस्तथा श्रोणि । (I 40)

1 7 यत्र पुरस्तादंहीयसी मिनुयात्तत्र तदर्धे लक्षण करोति । (I 41)

1 8 अथापरम् । प्रमाणादध्यर्धां रज्जुमुभयतः पाशां कृत्वा परस्मिंस्तृतीये षड्भागोने लक्षण करोति । (I 42), तन्यञ्चन । (I 43), इष्टेऽसार्थ । पृष्ठ्यान्तयोः पाशौ प्रतिमुच्य न्यञ्छनेन दक्षिणापारम्येष्टेन श्रोण्यंसान्निर्हरेत् । (I 44)

Indological Truths

1 9 समचतुरस्रस्याक्ष्णयारज्जुर्द्विस्तावती भूमिं करोति । (I 45)

1 10 प्रमाणं तिर्यग्द्विकरण्यामश्तस्याक्ष्णयारज्जुस्त्रिकरणी । (I 46)

1 11 तृतीयकरण्येतेन व्याख्याता । नवमस्तु भूमेर्भागो भवतीति । (I 47)

1 12 दीर्घचतुरस्रस्याक्ष्णयारज्जुः पार्श्वमानी तिर्यङ्मानी च यत्पृथग्भूते करुतस्तदुभयं करोति । (I 48)

1 13 तासां त्रिकचतुष्कयोर्द्वादशिकपञ्चिकयोः पञ्चादशिकाष्टिकयोः सप्तिकचतुर्विंशिकयोर्द्वादशिक पञ्चत्रिंशिकयोः पञ्चदशिकषट्त्रिंशिकयोरित्येतासूपलब्धिः । (I 49)

2

2 1 नानाचतुरस्रे समस्यङ्कनीयसः करण्या वर्षीयसो वृध्नमुल्लिखेत् वृध्नस्याक्ष्णयारज्जुः समस्तयोः पार्श्वमानी भवति । (I 50)

2 2 चतुरश्रञ्चतुरस्रं निर्जिहीर्षन्यावन्निर्जिहीर्षेत्तस्य करण्या वर्षीरसो वृध्नमुल्लिखेत् । वृध्नस्य पार्श्वमानीमक्ष्णयेतरत्पार्श्विमुपसंहरेत् । सा यत्र निपतेत्तदपच्छिन्द्यात् । छिन्नया निरस्तम् । (I 51)

2 3 समचतुरस्रं दीर्घचतुरस्रं चिकीर्षंस्तदक्ष्णयापच्छिद्या भागं द्वेधा विभज्य पार्श्वयोरुपदध्याद्यथा योगम् । (I 52)

2 4 अपि वैतस्मिंश्चतुरस्रं समस्य तस्य करण्यापच्छिद्य यदतिशिष्यते तदितरतरोपदध्यत् । (I 53)

2 5 दीर्घचतुरस्रं समचतुरस्रं चिकीर्षंस्तिर्यङ्मानी करणी कृत्वा शेषं द्वेधा विभज्य पार्श्वेयोरुपदध्यात् । खण्डमावापेन तत्सम्पूरयेत् । तस्य निर्हार उक्तः । (I 54)

2 6 चतुरस्रमेकतोऽणिमच्चिकीर्षन्नणिमतः करणी तिर्यङ्मानी कृत्वा शेषमक्ष्णया विभज्य विपर्यस्येतरत्रोपदध्यात् । (I 55)

2 7 चतुरस्रं प्रौगं चिकीर्षन्यावच्चिकीर्षेद्द्विस्तावती भूमी समचतुरस्रां कृत्वा पूर्वस्याः करण्याः मध्ये शङ्कुं निहन्यात् । तस्मिन्पशौ प्रतिमुच्य दक्षिणोत्तरयोः श्रोण्योर्निपातयेत् । बहिःस्पन्द्यमपच्छिन्द्यात् । (I 56)

2 8 चतुरस्रमुभयतः प्रौगं चिकीर्षन्यावच्चिकीर्षेद्द्विस्तावती भूमिं दीर्घचतुरस्रं कृत्वा पूर्वस्याः करण्याः मध्ये शङ्कुं निहन्यात् । तस्मिन्पाशौ प्रतिमुच्य दक्षिणोत्तरयोर्मध्यदेशयोर्निपातयेत् । बहिःस्पन्द्यमपच्छिन्द्यात् । एतेनापरं प्रौगं व्याख्यातम् । (I 57)

2 9 चतुरस्रं मण्डलं चिकीर्षन्नक्ष्णार्धं मध्यात्प्राचीमभ्यापातयेत् । यदतिशिष्यते तस्य सह तृतीयेन मण्डलं परिलिखेत् । (I 58)

2 10 मण्डलं चतुरस्रं चिकीर्षन्विष्कम्भमष्टौ भागान् कृत्वा भागमेकोनत्रिंशधा विभज्याष्टाविंशति भागानुद्धरेत् । भागस्य च षष्ठमष्टमभागोनम् । (I 59)

Indological Truths

2 11 अपि वा पञ्चदशभागान् कृत्वा द्वावुद्धरेत् । सैषानित्या चतुरस्रकरणी । (I 60)

2 12 प्रमाण तृतीयेन वर्धयेत्तच्च चतुर्थेनात्मचतुस्त्रिंशोनेन । (I 61), सविशेषः । (I 62)

3

3 1 अथाग्न्याधेयिके विहारः । (I 63), गार्हपत्यादाहवनीयस्यायतनम् । (I 64), विज्ञायतेऽष्टसु प्रक्रमेषु ब्राह्मणोऽग्निमादधीतैकादशसु राजन्यो द्वादशसु वीश्य इति । (I 65-66)

3 2 आयामतृतीयेन त्रीणि चतुरस्राण्यनूचिनानि कारयेत् । अपरस्योत्तरस्या श्रोण्यां गार्हपत्यः । तस्यैव दक्षिणेऽसेऽन्वाहार्यपचनः पूर्वस्योत्तरेऽसा आहवनीयः । (I 67)

3 3 अपि वा गार्हपत्याहवनीययोरन्तराल पञ्चधा षोढा वा सम्भुज्य षष्ठ सप्तमं वा भागमागन्तुकमुपसमस्य समं त्रैधं विभज्य पूर्वस्मादन्ताद्द्वयोर्भागयोर्लक्षणं करोति । गार्हपत्याहवनीयोरन्तौ नियम्य लक्षणेन दक्षिणापायम्य लक्षणे शङ्कुं निहन्ति । तद्दक्षिणाग्नेरायतनं भवति । (I 68)

3 4 अपि वा प्रमाणं पञ्चमेन वर्धयेत् । तत्सर्वं पञ्चधा सम्भूज्यापरस्मादन्ताद्द्वयोर्भागयोर्लक्षण करोति । पृष्ठ्यन्तयोः पाशौ प्रतिमुच्य लक्षणेन दक्षिणापायम्य लक्षणे शङ्कु निहन्ति । तद्दक्षिणाग्नेरायतनं भवति । (I 69)

3 5 विपर्यस्तैतेनोत्करो व्याख्यातः । (I 70)

3 6 अपरेणाहवनीयं यजमानमात्री भवतीति दार्शपौर्णमासिकाया वेदेर्विज्ञायते । (I 71)

3 7 तस्यास्त्रीभागोनं पश्चात्तिरश्चि । तस्या एवार्धं पुरस्तात्तिरश्चि । एवं दीर्घचतुरश्रमेकतोऽणिमद्विहृत्य स्रक्तिषु शङ्कून्निहन्यात् । (I 72)

3 8 यावती पार्श्वमानी द्विरभ्यस्ता तावतिं रज्जुमुभयतः पाशा कृत्वा मध्ये लक्षणं करोति । दक्षिणयोः पार्श्वयोः पाशौ प्रतिमुच्य लक्षणेन दक्षिणापायम्य लक्षणे शङ्कुं निहन्येत् । तस्मिन्पाशौ प्रतिमच्य लक्षणेन दक्षिणं पार्श्वं परिलिखेत् । (I 73), एतेनोत्तरं पार्श्वं व्याख्यातम् । (I 74), पूर्वं पार्श्व तया द्विरभ्यस्तया परिलिखेत् । एवमपरम् । (I 75)

3 9 दशपदा पश्चात्तिरश्ची द्वादशपदा प्राच्यष्टापदा पुरस्तात्तिरश्चीति पाशुबन्धिकाया वेदेर्विज्ञायते । मानयोगस्तस्या व्याख्यातः । (I 76), रथसम्मितेत्येकेषां । (I 77), विराट्सम्पन्नेत्येकेषाम् । (I 78)

3 10 शम्यामात्री चतुःस्रक्तिर्भवतीत्युत्तरवेदेर्विज्ञायते । (I 79), समचतुरस्राविशेषात् । (I 80)

3 11 वितृतीया वेदिर्भवतीति पैतृक्या वेदेर्विज्ञायते । (I 81), महावेदेस्तृतीयेन समचतुरस्रकृतायास्तृतीय करभी भवतीति । नवमस्तु भूमेर्भागो भवति । (I 82), यजमानमात्री चतुःस्रक्तिर्भवतीत्येकेषाम् । (I 83), दिक्षु स्रक्तयो भवन्ति । (I 84)

Indological Truths

3 12 वेदितृतीये यजेतेति सौत्रामणिकी वेदिमभ्युपदिशन्ति । (I 85), महावेदेस्तृतीयेन समचतुरस्रकृताया अष्टादशपदा पार्श्वमानी भवति । (I 86), तस्यै दीर्घकरण्यामेकतोऽणिमत्करण्या च यथाकामीति । (I 87)

4

4 1 प्राग्वंशः षोडशप्रक्रमायामो द्वादशव्यासोऽपि वा द्वादशप्रक्रमायामो दशव्यासाः । (I 88)

4 2 तस्य मध्ये द्वादशिको विहारः । (I 89)

4 3 त्रिंशत्पदानि प्रक्रमा वा पश्चात्तिरश्ची भवति षट्त्रिंशत्प्राची चतुर्विंशतिः पुरस्तात्तिरश्चीति महावेदेर्विज्ञायते । मानयोगस्तस्या व्याख्यातः । (I 90), आहवनीयात्षट् प्रक्रमानमहावेदिः । (I 91)

4 4 तत एकस्मिन्सदः । (I 92), तद्दशकम् । (I 93), उदक सप्तविंशत्यरत्नयः । (I 94), अष्टादशेत्येकेषाम् । (I 95)

4 5 ततश्चतुर्षु हविर्धानम् । तद्दशक द्वादशकं वा मानयोगस्तयोर्व्याख्यातः । (I 96)

4 6 यूपावटीयाच्छङ्कोरर्धप्रक्रममवशिष्योत्तरवेर्दि विमिमीते । (I 97), दशपदोत्तरवेदिर्भवतीति सोमे विज्ञायते । मानयोगस्तस्या व्याख्यातः । (I 98)

4 7 चत्वालः शम्यामात्रोऽपरिमितो वा । (I 99)

4 8 अथोपरवाः प्रादेशमुखाः प्रादेशान्तरालाः । (I 100), अरत्निमात्रं समचतुरस्रं विहृत्य स्रक्तिषु शङ्कून्निहान्यात् । अर्धप्रादेशेनार्धप्रादेशेनैकैक मण्डलं पारिलिखेत् । (I 101)

4 9 सदसः पूर्वार्धद्द्विप्रक्रममवशिष्य धिष्ण्यानां द्विप्रादेशो विष्कम्भस्तथान्तरालाः । (I 102)

4 10 आग्नीध्रागारस्य पार्श्वमानी पञ्चारत्निः । (I 103)

4 11 एतेन मार्जालीयो व्याख्यातः । (I 104), तस्योदीची द्वारं कुर्वन्ति । (I 105)

4 12 रथाक्षान्तराला यूपावटा भवन्तीत्येकादशिन्यां विज्ञायते । (I 106), तस्या दशानां च रथाक्षाणामेकादशाना च पदानामष्टाङ्गुलस्य च चतुर्विंश भागमाददीत । स प्रक्रमः स्यात् । तेन वेर्दि विमिमीते । (I 107)

4 13 अथाश्वमेधे विंशत्याश्च रथाक्षाणामेकविंशत्याश्च पदानामष्टाङ्गुलस्य च चतुर्विंशं भागमाददीत । स प्रक्रमः स्यात् । तेन वेर्दि विमिमीते । (I 108)

4 14 अथ प्राच्येकादशिन्यां यूपार्थ वेदेः पूर्वार्धत्पदार्धव्यासमपच्छिद्या तत्पुरस्तात्प्राञ्चं दध्यात् । (I 109), नात्राष्टाङ्गुलं विद्यते । (I 110), न व्यतिषङ्गः । (I 111)

4 15 यूपावटः पदविष्कम्भान्त्रिपदपरिणाहानि यूपोपाराणीति । (I 112)

Indological Truths

5

5 1 अर्धाष्टमाः पुरुषाः प्रथमोऽग्निः । (II 1), अर्धनवमाद्द्वितीयः । (II 2), अर्धदशमास्तृतीयः । (II 3), एवमुत्तरोत्तरो विधाभ्यासा एकशताविधात् । (II 4), तदेतत्सप्तविधप्रभृत्येकशतविधान्तम् । (II 5)

5 2 अत ऊर्ध्वमेकशतविधानेव प्रत्याददीत । (II 6), अनग्निकान्वा यज्ञक्रतूनाहारेत् । (II 7), अन्यत्राश्वमेधात् । (II 8)

5 3 अश्वमेधमप्राप्तं चेदाहरेदत ऊर्ध्वं विधामभ्यस्येन्नेतरदाद्रियेत् । (II 9)

5 4 अतीतं चेदाहरेदाहृत्य कृतान्तादेव प्रत्याददीत् । (II 10)

5 5 कथमु खलु विधामभ्यस्येत् । (II 11)

5 6 यदन्यत्प्रकृतेस्तत्पञ्चदश भागान् कृत्वा विधायां विधायां द्वौ द्वौ भागं समस्येत् । ताभिरर्धाष्टमाभिरग्निं चिनुयात् । (II 12)

5 7 ऊर्ध्वप्रमाणाभ्यासं जानोः पञ्चमस्य चतुर्विंशेनैके समामनन्ति । (II 13)

5 8 अथ हैक एकविधप्रभृतीनपक्षपुच्छांश्छिन्वते । (II 14)

5 9 तन्नपपद्यते पूर्वोत्तरविरोधात् । (II 15)

5 10 अथ हैकेषा ब्राह्मण भवति श्येनचिदग्नीना पूर्वा ततिरिति । (II 16)

5 11 अथापरेषां न ज्यायाशं चित्वा कनीयांशं चिन्वतेति । (II 17-18)

5 12 अथास्माकम् । (II 19), पक्षी भवति । न ह्यपक्षः पतितुमर्हति । अरत्निना पक्षौ द्राघीयाशौ भवतः । तस्मात्पक्षप्रवयासि वयांसि । व्याममात्रौ पक्षौ च पुच्छ च भवतीति । (II 20)

5 13 नापक्षपुच्छः श्येनो विद्यते । न चासप्तविधस्य पक्षपुच्छानि विद्यन्ते । न च सप्तविधं चित्वैकविधप्रसङ्गः । तस्मात्सप्तविध एव प्रथमोऽग्निः । (II 21)

5 14 भेदान्वर्जयेत् । (II 22), अधरोत्तरयोः पार्श्वसन्धानं भेदा इत्युपदिशन्ति । (II 23), तदग्न्यान्तेषु न विद्यते न श्रक्तिपार्श्वयोः । (II 24-25)

5 15 साहस्रं चिन्वीत प्रथमं चिन्वान इति । (II 26)

5 16 पञ्चमायां वा चितौ सङ्ख्या पूरयेत् । (II 27)

5 17 द्विशतेश्चेच्चिकीर्षेत्पञ्चचोडाभर्नाकासदःसमानसङ्ख्यं प्रतीयात् । (II 28)

Indological Truths

6

6 1 पशुधर्मो ह वा अग्निः । यथा ह वै पशोर्दक्षिणेषामस्थ्नां यद्दक्षिणं पार्श्वं तदुत्तरेषामुत्तरं यदुत्तरेषां दक्षिणं तद्दक्षिणेषामुत्तरं यदवाक् चोर्ध्वं च तत्समानमेवमष्टकाना रूपान्युपदध्यात् । (II 29)

6 2 या दक्षिणावृतो लेखास्ता दक्षिणता उपदध्यात् (II 30) सव्यावृत उत्तरतः । (II 31), ऋजुलेखाः पश्चाच्च भवन्ति । (II 32), त्र्यालिखिता मध्ये । (II 33), अथ या विशयस्था यथा ह वै पशोः पृष्ठवंशो नैवैकस्मिन्पार्श्वे व्यतिरेकेण वर्तते नैवापरस्मिन्नेव तासामुपधान प्रतीयात् । (II 34)

6 3 अथापि ब्राह्मणं भवति । (II 35), प्रजापतिर्वा अथर्वाग्निरेव दध्यङ्डाथर्वणस्तस्येष्टका अरथानीति । (II 36)

6 4 तस्माद्वहिस्तन्वं चेच्चिनुयात्तन्वोपप्लवमध्यैरात्मोपप्लवमध्यात् सन्दध्यात् । (II 37)

6 5 प्राञ्चमेनं चिनुत इति विज्ञायते । (II 38)

6 6 अमृन्मयीभिरनिष्टकाभिर्न सङ्ख्यां पूरयेत् । (II 39)

6 7 इष्टकचिद्वा अन्योऽग्निः पशुचिदन्य इत्येतस्माद्ब्राह्मणात् । (II 40)

6 8 पशुर्वा एष यदग्निर्योनिः खलु वा एषा पशुर्विक्रियते यत्प्राचीनमैष्टकाद्यजुः क्रियत इति च । (II 41)

6 9 लोकबाधीनि द्रव्याण्यवटेषूपदध्यात् । (II 42)

6 10 मण्डलमृषभं विकर्णीमितीष्टकासु लक्ष्माणि प्रतीयात् । (II 43)

6 11 इष्टकामन्त्रयोरिष्टकाव्यतिरेके लोकम्पृणाः सम्पद्यन्ते परिमाणाभावात् । (II 44)

6 12 अतीतानेव वेष्टकागणानतरोपदध्यात् । (II 45)

6 13 पञ्च लोकम्पृणाः । (II 46)

6 14 मन्त्रव्यतिरेकेऽक्ताः शर्कराः सन्धिषूपदध्यात् । (II 47)

6 15 प्राचीरुपदध्याति प्रतीचीरुपदध्यातीति गणेषु रीतिवादः । (II 48)

6 16 प्राचीमुपदधाति प्रतीचीमुपदधातीति कर्तुर्मुखवादः । (II 49)

6 17 पुरस्तादन्यः प्रतीचीरुपदधाति पश्चादन्यः प्राचीरित्यपवर्गः । (II 50)

6 18 चतुरस्रास्त्वेवैतदुपपद्यते । (II 51)

7

7 1 न खण्डामुपदद्यात् । (II 52), न भिन्नामुपदध्यात् । (II 53), न कृष्णामुपदध्यात् । (II 55), न जीर्णामुपदध्यात् । (II 54), न लक्ष्मणामुपदध्यात् । (II 56), न स्वयमातृण्णाम स्वयञ्चितावुपदध्यात् । (II 57)

Indological Truths

7 2 ऊर्ध्वप्रमाणमिष्टकानां जानोः पञ्चमेन कारयेत् । (II 58), अर्धेन नाकसदा पञ्चचोडानां च । (II 59)

7 3 यच्छोषपाकाभ्यां प्रतिह्रसेत पुरीषेण तत्सम्पूरयेत् पुरीषस्यानियतपरिमाणत्वात् । (II 60)

7 4 व्यायाममात्री भवतीति गार्हपत्यचितेर्विज्ञायते । (II 61)

7 5 चतुरश्रेत्येकेषाम् । (II 62), परिमण्डलेत्येकेषाम् । (II 63)

7 6 चतुरश्रं सप्तधा विभज्य तिरश्चिं त्रेधा विभजेत् । (II 64), अपरस्मिन्प्रस्तार उदीचीरुपदधाति । (II 65)

7 7 समचतुरश्राश्चेदुपदध्याद्(II 66-67)व्यायामषष्ठेनेष्टकाः कारयेच्चतुर्थेन तृतीयेनेति । (II 66-67), तासां नव प्रथमा द्वादश द्वितीया इति पूर्वस्मिन्प्रस्तार उपदधाति । (II 68), पञ्च तृतीयाः षोडश प्रथमा इत्यपरस्मिन् । (II 69))

7 8 परिमण्डलायां यावत्सम्भवेत्तावत्समचतुरस्रं कृत्वा तन्नवधा विभजेत् (II 70) प्रधीस्त्रिधा त्रिधेति । (II 71), अपरं प्रस्तारं तथोपदध्याद्यथा प्रध्यनीकेषु स्रक्तयो भवन्ति । (II 72)

7 9 धिष्ण्या एकचितीकाश्चतुरश्राः परिमण्डला वा । (II 73)

7 10 तेषामाग्नीध्रियं नवधा विभज्यैकस्याः स्थानेऽस्मानमुपदध्यात् । (II 74)

7 11 अथ होतुर्धिष्ण्यं नवधा विभज्य पूर्वांस्त्रिभागानेकैक द्वेधा विभजेत् । (II 75)

7 12 अथेतरान्नवधा नवधा विभज्य मध्यमपूर्वौ द्वौ भागौ समस्येत् । (II 76)

7 13 अथ मार्जालीयं त्रेधा विभज्य पूर्वापरौ भागौ पञ्चधा विभजेत् । (II 77)

7 14 उख्यभस्मना संसृज्येष्टकाः कारयेदिति । (II 78)

7 15 संवत्सरभृता एवैतदुपपद्यते न रात्रिभृतः । (II 79)

7 16 एवमस्य मन्त्रवती चितिक्लृप्तिः । (II 80)

7 17 छन्दश्चितं त्रिषाहस्रस्य परस्ताच्चिन्वित (II 81) कामविवेकात् तस्य रूपंश्येनाकृतिर्भवतीति । (II 83)

8

8 1 अथ वै भवति श्येनचितं चिन्वीत सुवर्गकाम इति । (III 1)

8 2 आकृतिद्वैविध्यम् । (III 2), चतुरस्रात्मा । (III 3), श्येनाकृतिश्च । (III 4)

8 3 विज्ञायते उभयं ब्राह्मणम् । (III 5-6)

8 4 पञ्च दक्षिणायां श्रोण्यामुपदधाति पञ्चोत्तरस्याम् । बस्तो वय इति दक्षिणेऽश उपदधाति । वृष्णिर्वय

Indological Truths

इतियुत्तरे । व्याघ्रो वय इति दक्षिणे पक्ष उपदधाति । सिंहो वय इत्युत्तरे पुरुषो वय इति मध्य इति च । (III 7)

8 5 अथापरम् । वयसां वा एष प्रतिमया चीयते यदग्निरिति । (III 8), उत्पततां छाययत्यर्थः । (III 9)

8 6 समचतुरस्राभिरग्निं चिनुते दैव्यस्य च मानुषस्य च व्यावृत्त्या इति मैत्रायणीयब्राहमणं भवति । (III 10)

8 7 तस्येष्टकाः कारयेत् पुरुषस्य चतुर्थेन पञ्चमेन षष्ठेन दशमेनेति । (III 11) 8 8)

8 8 अथाग्निं विमिमीते । (III 12)

8 9 यावान्पुरुष ऊर्ध्वबाहुस्तावदन्तराले वेणोश्छिद्रे करोति । (III 13), मध्ये तृतीयम् । (III 14), यदमुत्र स्पन्द्यया करोति तदिह वेणुना करोति । (III 15)

8 10 तस्यात्मा । (III 16), समचतुरस्रश्चत्वारः पुरुषाः । (III 17), पक्षः समचतुरस्रः पुरुषः । (III 18), स तु दक्षिणतोऽरत्निना द्राघीयान् । (III 19), एतेनोत्तरः पक्षो व्याख्यातः । (III 20), पुच्छः समचतुरस्रः पुरुषः । (III 21), तमवस्तात्प्रादेशेन वर्धयेत् । (III 22), एवं सारत्नि प्रादेशा सप्तविधः सम्पद्यते । (III 23)

8 11 उपधाने पक्षाग्रादुत्तरतः पुरुषतृतीयवेलायाम् । (III 24), चतस्रः पञ्चम्यस्तासामभितो द्वे द्वे पादेष्टके । (III 25), ततोऽष्टौ चतुर्थ्यः । (III 26), पक्षशेष षड्भागीयाभिः प्रच्छादयेत् । (III 27), एतेनोत्तरः पक्षो व्याख्यातः । (III 28)

8 12 पूर्वापरयोः पुच्छपार्श्वयोश्चतुर्भागीया उपदध्यात् । (III 29), दक्षिणोत्तरयोः पादेष्टकाः । (III 30), शेषमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् । (III 31)

8 13 एष द्विशतः प्रस्तारः । (III 32)

8 14 अपरस्मिन्प्रस्तारे । (III 33), पक्षाग्रादुत्तरतोऽर्धव्यायामवेलायां तिस्रस्तिस्रः षष्ठ्यो द्वे द्वे द्विपदे इति विपर्यासमुपदध्यात् । (III 34), तथोत्तरे । (III 35)

8 15 दक्षिणस्यां श्रोण्यां नव षष्ठ्यश्चतुरश्रकृताः । (III 36), तथोत्तरस्याम् । (III 37)

8 16 नव नव षष्ठ्यो द्वे द्वे द्विपदे इति दक्षिणादंशादुत्तरादंशाद्विपर्यासमुपदध्यात् । (III 38)

8 17 शेषमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् । (III 39)

8 18 एष द्विशतः प्रस्तारो व्यत्यासं चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत । (III 40)

Indological Truths

9

9 1 अथापरः । (III 41)

9 2 पुरुषस्य पञ्चम्यः । (III 42), ता एवैकतोऽध्यर्धाः । (III 43), तासामर्ध्याः पाद्याश्च । (III 44-45)

9 3 उपधाने । (III 46), पूर्वापरयोः पक्षपार्श्वयोरर्धेष्टका उदीचीरुपदध्यात् । (III 47), तथोत्तरे । (III 48)

9 4 दक्षिणोत्तरयोः पुच्छपार्श्वयोश्चतस्रश्चतस्रोऽध्यर्धा उदीचीः । (III 49), पुच्छस्यावस्ताच्चतस्रोऽर्धेष्टका उदीदीः । (III 50), तासामभितो द्वे पादेष्टके । (III 51), जघनेन पुच्छाप्ययोरेकैकामर्धेष्टकां प्राचीम् । (III 52)

9 5 शेषमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् । (III 53)

9 6 एष द्विशतः प्रस्तारः । (III 54)

9 7 अपरस्मिन् प्रस्तार आत्मंस्रक्तिषु चतस्रः पादेष्टका उपदध्येत् । (III 55), तासामभितो द्वे द्वे अर्धेष्टके । (III 56), पूर्वस्मिन्ननीके पञ्च । (III 57)

9 8 पक्षाग्रयोस्तिस्रस्तिस्रोऽध्यर्धा उदीचीः । (III 58), तासामन्तरालेष्वेकैकामर्धेष्टकां प्राचीम् । (III 59)

9 9 शेषमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् । (III 60)

9 10 एष द्विशतः प्रस्तारो व्यत्यासं चिनुयाद्यावतः प्रस्ताराश्चिकीर्षेत् । (III 61)

10

10 1 अथ वक्रपक्षो व्यस्तपुच्छः । (III 62)

10 2 तस्येष्टकाः कारयेत्पुरुषस्य चतुर्थ्यः । (III 63), तासामर्ध्याः पाद्याश्च । (III 64), नित्यमक्ष्ण्यापच्छेदनमनादेशे । (III 65)

10 3 पादेष्टकाश्चतुर्भिः परिगृह्णीयादर्धपदेन पादेनाध्यर्धपदेन पदसविशेषेणेति । (III 66-67), ते द्वे यथा दीर्घसंश्लिष्टे स्यातां तथार्धेष्टकां कारयेत् । (III 68)

10 4 अथाग्नि विनिमीत । आत्मा द्विपुरुषायाम दशपदव्यासः । (III 69), तस्य दक्षिणादंशादुत्तरतोऽध्यर्ध प्रक्रमे लक्षणं करोति । (III 70), एवमपरतः । (III 71), तयोरुपरिष्टात्पन्द्या नियम्यांशमपच्छिन्द्यात् । (III 72), एतेनेतरासां स्रक्तीनामपच्छेदा व्याख्याताः । (III 73), स आत्मा । (III 74)

10 5 शिरोऽर्धषष्ठपदायाममर्धपुरुषव्यासं । तस्यांशौ प्रक्रमेण प्रक्रमेणापच्छिन्द्यात् । (III 75)

Indological Truths

10 6 पुच्छस्य षट्पदा प्राची द्विपुरुषोदीची। (III 76), तस्य पूर्वे स्रक्ति त्रिभिस्त्रिभिः प्रक्रमैरपच्छिन्द्यात् । (III 77)

10 7 पक्षो द्वादशपदायामो दशपदव्यासः । (III 78), तस्य मध्यात् प्राञ्चि षट्पदानि प्रक्रम्य शङ्कुं निहन्यात् । (III 79), श्रोण्योरेकैकम् । (III 80), अथैनं स्पन्द्यया परिचिनुयात् । (III 81), अन्तस्पन्द्यमपच्छिद्य तत्पुरस्तात् प्राञ्चं दध्यात् । (III 82), स निर्णामः । (III 83), एतेनोत्तरस्य पक्षस्य निर्णामो व्याख्यातः । (III 84)

10 8 पक्षाग्रयोः प्रक्रमप्रमाणानि पञ्च पञ्च चतुरश्राण्यनूचीनानि कृत्वा सर्वाण्यवाञ्चमक्ष्णया पच्छिन्द्यादर्धान्युद्धरेत् । (III 85)

10 9 एवं सारत्रिप्रादेशः सप्तविधः सम्पद्यतः । (III 86)

10 10 उपधाने शिरसोऽप्यये चतुर्थिमुपदध्यात् । (III 87), हंसमुखी पुरस्तात् । (III 88), पादेष्टके अभितः । (III 89), तयोरवस्तादभितस्तिस्रस्तिस्रश्चतुरश्रपाद्यः । (III 90), शेषे पादेष्टकाः । (III 91)

10 11 अपि वा शिरसोऽग्रे हंसमुखीमुपदध्यात् तस्य अवस्ताच्चतुर्थिमुपदध्यात्पादेष्टके अभितः । तयोरवस्तादभितस्तिस्रस्तिस्रश्चतुरश्रपाद्याः । शेषे पादेष्टकाः । (III 92)

10 12 शिरसोऽवस्तात्पञ्चपादेष्टका व्यतिषक्ता उपदध्यात् । (III 93), तथा पुच्छस्य पुरस्तात् । (III 94), यद्यदपच्छिन्नं तस्मिन्नर्धेष्टकाः पादेष्टकाश्चपदध्यात् । (III 95)

10 13 शेषमग्निं चतुर्भागीयाभिः प्रच्छादयेत् । (III 96), पाद्याभिः सार्ध्याभिः सङ्ख्यां पूरयेत् । (III 97)

10 14 एष द्विशतः प्रस्तारः ।

10 15 अपरस्मिन्प्रस्तारे हंसमुखीश्चतस्रश्चतस्रभिः पादेष्टकाभिः संयोजयेद्यथा दीर्घचतुरश्रं सम्पद्यते । तत्तिर्यक् स्वयमातृण्णावकाश उपदध्यति । (III 98)

10 16 हंसमुख्यौ प्रतीच्यौ पुच्छाप्ययेऽर्धपदेनात्मनि विषये । (III 99), तयोरवस्तादभितस्तिस्रः पादेष्टकाः प्राङ्मुखीरुपदध्यात् । (III 100)

10 17 पुच्छस्यावस्तात्पञ्चदश पादेष्टका व्यतिषक्ता उपदध्यात् । (III 101)

10 18 पादेष्टके अर्धेष्टकेति पक्षपत्राणां प्राचीर्व्यत्यासं चिनुयात् । (III 102)

10 19 विशये यदपच्छिन्नं तस्मिन्नर्धेष्टकाः पादेष्टकाश्चोपदध्यात् । (III 103)

10 20 शेषमग्निं चतुर्भागीयाभिः प्रच्छादयेत् । पाद्याभिः सार्ध्याभिः सङ्ख्यां पूरयेत् । (III 104)

Indological Truths

11

11 1 अथापरः । (III 105)

11 2 पुरुषस्य पञ्चमीभिः शतमशीतिः सप्तार्धं च सारत्निप्रदेशः सप्तविधः सम्पद्यते । (III 106)

11 3 तासां पञ्चाशद्द्वे चात्मनि(III 107)अर्धचतुर्थ्यः शिरसि । (III 108), पञ्चदश पुच्छे । (III 109), अष्टपञ्चाशत्सार्ध्या दक्षिणे पक्ष उपदध्यात् । (III 110), तथोत्तरे । (III 111)

11 4 अर्धव्यायामेन स्रक्तीनामपच्छेदः । (III 112), सप्तात पुच्छम् । (III 113), पक्षयस्त्रिभिस्त्रिभिररत्निभिरपनामः । (III 114), अध्यर्ध्यभिः षट् षट् पत्राणि कुर्यात् । (III 115), आकृतिः शिरसो नित्या । (III 116)

11 5 अथेष्टकानां विकारः । (III 117)

11 6 पुरुषस्य पञ्चम्यस्ता एवैकतोऽध्यर्धः । (III 118), ता एवैकतः सपादाः । (III 119), पञ्चमभागीयायाः पाद्याः सार्ध्याः । (III 120), तथाध्यर्धायाः । (III 121), तयोश्चाष्टमभागौ तथा श्लेषयेद्यथा तिस्रः स्रक्तयो भवन्ति । (III 122), पञ्चमभागीयायाश्चाष्टम्यः । (III 123), तानि दश । (III 124)

11 7 आत्मनि पञ्चमभागीयाः सार्ध्या उपदध्यात् । (III 125), तथा पुच्छे । (III 126)

11 8 पक्षयोश्चाध्यर्धाः सार्ध्यः । (III 127)

11 9 शिरसि याः सम्भवन्ति । (III 128)

11 10 अपरस्मिन्नस्तारे पूर्वयोः पक्षाप्ययोरेकैकामुभयीमुपध्यात् । (III 129), एकैकामपरयोः । (III 130), द्वे द्वे शिरसः पार्श्वयोः । (III 131)

11 11 पुच्छस्यावस्तादध्यर्धाः प्राचीर्यथावकाशम । (III 132), पार्श्वयोः पाद्याः षष्टमभागाः । (III 133)

11 12 पक्षयोश्चाध्यर्धाः सावयवाः । (III 134)

11 13 शेषं यथायोगं यथासङ्ख्यं यथाधर्मं चोपदध्यात् । (III 135)

12

12 1 कङ्कचिता एतेनात्मा पुच्छ च व्याख्यातम् । (III 136)

12 2 शिरसि पञ्चपदध्यात् । (III 137), तस्याकृतिर्व्याख्यात । (III 138)

12 3 सप्तपञ्चाशद्दक्षिणे पक्ष उपदध्यात् । (III 139), तथोत्तरे । (III 140)

12 4 व्यायामेन सप्रदेशेन पक्षयोरपनामः । (III 141), पञ्चमभागीयार्ध्याभिः षट् षट् पत्राणि कुर्यात् । (III 142), अध्यर्धावशिष्यते । (III 143)

Indological Truths

12 5 तया पुच्छस्यावस्तात् पादावरत्निमात्रावरत्न्यन्तरालौ प्रादेशव्यासौ भवन्तः । (III 144), तयोरवस्तादभितो द्वौद्वावष्टमभागौ प्राग्भेदावुपदध्यात् । (III 145)

12 6 एवं सारत्निप्रादेशः सप्तविधः सम्पद्यते । (III 146)

12 7 अथेष्टकानां विकाराः । पञ्चमभागीयाः सावयवाः । (III 147), पादेष्टकां चतुर्भिः परिगृह्णीयात्(III 148) अर्धप्रादेशेनाध्यर्धप्रादेशेन प्रादेशेन प्रादेशसविशेषेनेति । (III 149), अध्यर्धेऽष्टकां चतुर्भिः परिगृह्णीयादर्धव्यायामेन द्वाभ्यामरत्निभ्यामरत्निसविशेषेनेति । (III 150), ताः षट् । (III 151)

12 8 तासां चतुरश्रपाद्याः साष्टमभागाः पादयोरुपधाय शेषं यथायोगं यथासङ्ख्यं यथाधर्मं चोपदध्यात् । (III 152)

13

13 1 अलजचित एतेनात्मा शिरः पुच्छं च व्याख्यातं पादावपोद्धृत्य । (III 153)

13 2 त्रिषष्टिर्दक्षिणे पक्ष उपदध्यात् । (III 154), तथोत्तरे । (III 155)

13 3 पुरुषेण पक्षयोरपनामः । (III 156)

13 4 अपरस्मादपनामात्प्राञ्चमरत्निं मित्वा तस्मिन्स्पन्द्यां नियम्यापरं पक्षपत्रापच्छेद् अमन्वायच्छेत् । (III 157)

13 5 एवं पञ्च पञ्चम्यः सार्ध्या उद्धृता भवन्ति । (III 158)

13 6 पादेष्टकामपनाम उपध्याय (III 159) तासां चतुरश्र पाद्याः साष्टमभागा अपोद्धृत्य शेषं यथायोग यथासङ्ख्यं यथाधर्मं चोपदध्यात् । (III 160)

14

14 1 प्रौगचितं चिन्वितेति । (III 161)

14 2 यावानग्निः सारत्निप्रादेशस्तावत्प्रौगं कृत्वा तस्यापरस्याः करण्या द्वादशेनेष्टकास्तदर्धव्यासाः कारयेत् । (III 162), तासामर्ध्याः पाद्याश्च । (III 163)

14 3 तासां द्वे अर्धेष्टके बाह्यसविशेषे चुबुक उपदध्यादर्ध्याश्चान्तयोः । (III 164-165)

14 4 शेषमग्निं बृहतीभिः प्रच्छादयेदर्धेष्टकाभिः सङ्ख्यां पूरयेत् । (III 166)

14 5 अपरस्मिन्प्रस्तारे परस्मिन्ननीके सप्तचत्वारिंशत्पदेष्टका व्यतिषक्ता उपदध्यात् । (III 167)

14 6 चुबुक एकां शूलपाद्याम् । (III 168)

Indological Truths

14 7 दीर्घे चेतरे चतस्रः स्वयमातृण्णावकाश उपदध्यात्(III 169)अर्ध्याश्चान्तयोः । (III 170)

14 8 शेषमग्निं बृहतीभिः प्राचीभिः प्रच्छादयेदर्धेष्टकाभिः सङ्ख्या पूरयेत् । (III 171)

15

15 1 उभयतः प्रौगं चिन्वीतेति । (III 172)

15 2 यावानग्निः सारत्निप्रादेशस्तावदुभयतः प्रौगं कृत्वा । (III 173), नवमेन तिर्यङ्मान्याः प्रौगचितोक्ता विकाराः । (III 174)

15 3 तथोपधानम् । (III 175)

15 4 अपरस्मिन्प्रस्तारे चुबुकयोर्द्वे पादेष्टके उपदध्यात् । (III 176), सन्ध्यन्तयोश्च दीर्घपाद्ये । (III 177)

15 5 दीर्घे चेतरे च चतस्रः स्वयमातृण्णावकाश उपदध्योदरध्याश्चान्तयोः । (III 178)

15 6 शेषमग्निं बृहतीभिः प्राचीभिः प्रच्छादयेदर्धेष्टकाभिः सङ्ख्याम पूरयेत् । (III 178)

16

16 1 रथचक्रचित चिन्वितेति विज्ञायते । (III 179)

16 2 द्वयानि तु खलु रथचक्राणि भवन्ति । (III 180), साराणि च प्रधियुक्तानि च । (III 181), विशेषात्ते मन्यामहेऽन्यतरस्याकृतिरिति । (III 182)

16 3 अथाग्निं विमिमीते । यावानग्निः सारत्निप्रादेशस्तावती भूमिं परिमण्डला कृत्वा तस्मिन्यावत्सम्भवेत्तावत् समचतुरश्रं कृत्वा । (III 183), तस्य करण्या द्वादशेनेष्टकाः कारयेत् । (III 184)

16 4 तासां षट् प्रधावुपधाय शेषमष्टधा विभजेत् । (III 185)

16 5 अपरं प्रस्तारं तथोपदध्याद्यथा प्रध्यनीकेषु स्रक्तयो भवन्ति । (III 186)

16 6 अथापरः । (III 187)

16 7 पुरुषार्धात्पञ्चदशेनेष्टकाः समचतुरश्राः कारयेन्मानार्थाः । (III 188)

16 8 तासां द्वे शते पञ्चविंशतिश्च सारत्निप्रादेशः सप्तविधः सम्पद्यते । (III 189)

16 9 तास्वन्याश्चतुःषष्टिमावपेत् । (III 190), ताभिः समचतुरश्रं करोति । (III 191), तस्य षोडधेष्टका पार्श्वमानी भवति । (III 192), त्रयस्त्रिंशदतिशिष्यन्ते । (III 193), ताभिरन्तान्सर्वशः परिचिनुयात् । (III 194)

Indological Truths

16 10 नाभिः षोडश मध्यमाः । (III 195), चतुःषष्टिरराश्चतुःषष्टिर्वेदिः । (III 196), नेमिः शेषाः । (III 197)

16 11 नाभिमन्ततः परिलिखेत् । (III 198), नेमिमन्ततश्चान्तरतश्च परिलिख्या । (III 199), नेमिनाभ्योरन्तरालं द्वात्रिंशद्धा विभज्य विपर्यास भागानुद्धरेत् । (III 200), एवमावाप उद्धृतो भवति । (III 201)

16 12 नेमिं चतुःषष्टिं कृत्वा व्यवलिख्या मध्ये परिक्षेत् । (III 202), ता अष्टाविंशतिशतं भवन्ति । (III 203)

16 13 अरंश्चतुर्धा चतुर्धा (III 204) नाभिमष्टधा विभजेत् । (III 205)

16 14 एष प्रथमः प्रस्तारः ।

16 15 अपरस्मिन्प्रस्तारे (III 206) नाभिमन्ततश्चतुर्थवेलायां परिकृषेत् । (III 207), नेमिमन्तरतः । (III 208)

16 16 नेमिमन्तरतश्चतुःषष्टिं कृत्वा व्यवलिखेत् । (III 209)

16 17 अराणां पञ्चधा विभाग आपरिकर्षणयोः । (III 210)

16 18 नेम्यामन्तरालेषु द्वे द्वे (III 211) नाभ्यामन्तरालेष्वेकैक । (III 212)

16 19 यच्छेषं नाभेस्तदष्टाधा विभजेत् । (III 213)

16 20 स एष षोडशकरणः सारो रथचक्रचित् । (III 214)

17

17 1 द्रोणचित चिन्वीतेति विज्ञायते । (III 215)

17 2 द्रयानि तु खलु द्रोणानि भवन्ति । (III 216), चतुरश्राणि च परिमण्डलानि च । (III 217), अविशेषात्ते मन्यामतहेऽन्यतरस्याकृतिरिति । (III 228)

17 3 अथाग्निं विमिमीते । चतुरश्र आत्मा भवन्ति । (III 219), तस्य त्रयः पुरुषास्त्रिभागोनाः पार्श्वमानि । (III 220)

17 4 पश्चात्सरुर्भवति । (III 221), तस्यार्धपुरुषो दशाङ्गुलानि च प्राची । (III 222), त्रिघागोनाः पुरुष उदीचीति । (III 223)

17 5 एव सारत्रिप्रदेशः सप्तविधः सम्पद्यते । (III 224)

17 6 अथेष्टकानां विकाराः । पुरुषस्य षष्ठ्यस्ता एवैकतोऽध्यर्धाः । तासामर्ध्यास्तिर्यग्भेदाः पुरुषस्य चतुर्थ्य इति । (III 225)

Indological Truths

17 7 तासां त्सरुश्रोण्यन्तरालयः षट् षष्टीरुपधाय शेषमग्निं बृहतीभिः प्रच्छादयेत् । (III 226), अर्धेष्टकाभिः सङ्ख्यां पारयेत् । (III 227)

17 8 अपरस्मिन्त्रस्तारे दक्षिणेऽशेऽध्यर्धामदीचीमुपदध्यात् । (III.228), तथोत्तरे । (III 229)

17 9 पूर्वस्मिन्ननीके षड्भागीया उपदध्यात् । (III 230)

17 10 दक्षिणोत्तरयोश्चतुर्भागीर्याः । (III 231)

17 11 त्सरोः पुरस्तात्पार्श्वयोर्द्वे चतुर्भागीये उपदध्यात् । (III 232), तयोरवस्तादभितो द्वे द्वे अध्यर्धे विषूची । (III 233), तयोरवस्तान्मध्यदेशे द्वे षष्ठ्यौ प्राच्यौ । (III 234)

17 12 शेषमग्निं बृहतीभिः प्राचीभिः प्रच्छादयेत् । (III 235), अर्धेष्टकाभिः सङ्ख्यां पूरयेत् । (III 236)

18

18 1 अथापरः । (III 237)

18 2 पुरुषस्य षोडशीभिर्विंशशतं सारत्निप्रदेशः सप्तविधः सम्पद्यते । (III 238)

18 3 तासामेकामपोद्धृत्य शेषाः परिमण्डलं करोति । (III 239)

18 4 तत्पूर्वेण रथचक्रचिता व्याख्यातम् । (III 240)

18 5 षोडशी पुरस्ताद्विषय उपाधाय तया सह मण्डलं परिलिखेत् । (III 241)

18 6 यदवस्तादपच्छिन्नं तत्पुरस्तादुपदध्यात् । (III 242)

18 7 प्रधीनां सप्तधा विभागः । (III 243)

18 8 प्रधिमध्यमाः प्रक्रमव्यासू भवन्ति । (III 244)

18 9 चतुरश्राणामर्ध्याभिः सङ्ख्या पूरयेत् । (III 245)

18 10 अपरस्मिन्त्रस्तारे (III 246), प्रधिमध्यमामोष्ठा उपधाय यदवास्तात्तद्द्वेधा विभजेत् । (III 247)

18 11 स एष नवकरणो द्रोणचित्परिमण्डलः । (III 248)

18 12 समूह्य परिचाय्या पूर्वेण रथचक्रचिता व्याख्यातौ । (III 249)

18 13 समूह्यस्य दिक्षु चात्वालां खानयित्वा तेभ्यः पुरीषं समूह्योपदध्यात् । (III 250)

18 14 परिचाय्य इष्टाकानां देशभेदः । (III 251)

18 15 तं सर्वाभिः प्रदक्षिणं परिचिनुयात् । (III 252)

Indological Truths

19

19 1 श्मशानचितं चिन्वीतेति विज्ञायते । (III 253)

19 2 सर्वमग्निं चतुरश्रान्पञ्चदश भागान् कृत्वा । (III 254), तेषामाख्यातमुपधानम् । (III 254)

19 3 त्रिभिर्भागैर्भागार्धव्यासां दीर्घचतुरश्रं विहृत्य पूवस्याः करण्या मध्याच्छ्रोणी प्रत्यालिख्यान्तावुद्धरेत् । (III 255), तस्य दशधा विभागः । (III 256)

19 4 तानि विंशतिः सर्वोऽग्निः सम्पद्यते । (III 257)

19 5 अपरस्मिन्प्रस्तारे । (III 258), प्रौगमध्येऽनूचीनां विभजेत् । (III 259), तस्य षड्धा विभागः । (III 260), ते द्वे पार्श्वयोरुपदध्यात् । (III 261)

19 6 भागतृतीयायामश्चतुर्थव्यासाः कारयेत् । (III 262), तासामर्ध्यास्तिर्यग्भेदाः । (III 263)

19 7 ता अन्तयोरुपधाय शेषमग्निं बृहतीभिः प्राचीभिः प्रच्छादयेत् । (III 264), अर्धेष्टकाभिः सङ्ख्यां पूरयेत् । (III 265)

19 8 ऊर्ध्वप्रमाणमग्नेः पञ्चमेन वर्धयेत् । (III 266)

19 9 तत्सर्वं त्रेधा विभज्य द्वयोर्भागयोश्चतुर्थेन वा नवमेन वा चतुर्दशेन वेष्टकाः कारयेत् । (III 267)

19 10 ताभिश्चतस्रो वा नव वा चतुर्दश वा चितिपधाय शेषमवाञ्चमक्ष्णयापच्छिन्द्यात् । अर्धमुद्धरेत् । (III 268)

19 11 तस्य नित्य विभागो यथायोगनिष्ठकानां ह्रासवृद्धिः । (III 269)

20

20 1 कूर्मचितं चिन्विता यः कामयेत ब्रह्मलेकमभिजयेयमिति । (III 270), विज्ञायते ।

20 2 द्वयाः खलु कूर्मा भवन्ति वक्राङ्गाश्च परिमण्डलाश्च । (III 271), विशेषात्ते मन्यामहेऽन्यतरस्याकृतिरिति । (III 272)

20 3 अथाग्निं विमिमीते । चतुरश्र आत्म भवति । तस्य दशा प्रक्रमाः पार्श्वमानी भवति । (III 273)), तस्य द्वाभ्यां द्वाभ्यां प्रक्रमाभ्यां स्रक्तीनामपच्छेदः । (III 274)

20 4 पूर्वस्मिन्ननिके प्रक्रमप्रमाणानि चत्वारि चतुरश्राणि कृत्वा तेषां ये अन्त्ये ते अक्ष्णयापच्छिन्द्यात् । (III 275), एवं कक्षिणत एवं पश्चादेवमुत्तरतः । (III 276), स आत्मा । (III 277)

20 5 शिरः पञ्चपदायाममर्धपुरुषव्यासम् । (III 278), तस्याशौ प्रक्रमेण प्रक्रमेणापच्छिन्द्यात् । (III 279)

20 6 स्रक्त्यपच्छेदे पादानुन्नयेत् । (III 280), तस्य द्विपदाक्ष्णया तिरश्ची तद्द्विगुणाया ममनूची ।

Indological Truths

(III 281), तस्य द्विपदाक्ष्ण्या पूर्वमसमपच्छिन्द्यात् । (III 282), एतेनेतारेषा पादानामपच्छेदा व्याख्याताः । (III 283), अपरयोः पादयोरपरावशवपच्छिन्द्यात् । (III 284)

20 7 एवं सारन्निप्रदेशः सप्तविधः सम्पद्यते । (III 285)

20 8 तस्यष्टकाः कारयेत्पुरुषस्य चतुर्थ्यस्तासामर्ध्याः पाद्यश्च । (III 286)

20 9 अध्यर्धपाद्याश्चतुर्भिः परिगृह्णीयात्प्रक्रमेन द्वाभ्यां पदाभ्यां पदसविशेषेणेति । (III 287)

20 10 ते द्वे यथा दीर्घसश्लिष्टे स्याता तथैकां कारयेत् । (III 288)

20 11 द्विपदाक्ष्णयार्धेन समचतुरश्रामेकाम् । (III 289)

20 12 उपधाने शिरसोऽग्रे चतुरश्रामुपदध्यात् । (III 290), हंसमुख्याववस्तात् । (III 291) 20 13)

20 13 पञ्च पञ्च चतुरश्रा द्वे द्वे पादेष्टके इति पादेषूपदध्यात् । (III 292)

20 14 यद्यदपच्छिन्नं तस्मिन्नर्धेष्टका उपदध्यात् । (III 293)

20 15 शेषमग्निं चतुर्भाघीयाभिः प्रच्छादयेत् । (III 294), अर्धेष्टकाभिः सङ्ख्यां पूरयेत् । (III 295)

20 16 अपरस्मिन्प्रस्तारे शिरसोऽग्रे हसमुखीमुपदध्यात् पादेष्टके अभितः । (III 296)

20 17 तस्योरवस्तादभितो द्वे द्वे अध्यर्धपाद्ये विषूची । (III 2297)

20 18 तयोरवस्तादभितश्चेदसहिते द्वे पादेष्टके । (III 298)

20 19 द्वे द्वे द्विपदे तिस्रस्तिस्रोऽर्धेष्टका इति पादेषूपदध्यात् । (III 299)

20 20 यद्यदापच्छिन्नं तस्मिन्नर्धेष्टकाः पादेष्टकश्चोपदध्यात् । (III 300)

20 21 शेषमग्निं चतुर्भागीयाभिः प्रच्छादयेत् । (III 301), अर्धेष्टकाभिः सङ्ख्यां पुरयेत् । (III 302)

21

21 1 अथापरः । (III 303)

21 2 पुरुषस्य षोडशीभिर्वंशशतं सारन्निप्रादेशः सप्तविधः सम्पद्यते । (III 304)

21 3 तासां पञ्च षोडशीरपोद्धृत्य शेषाः परिमण्डल करोति । (III 305), तदुत्तरेण द्रोणचिता व्याख्यातम् । (III 306)

21 4 अथ ताः पञ्च षोडश्यस्ताभिरवान्तरदिक्षु पादानुन्नयेच्छिरः पुरसतात् । (III 307-308), तासा परिकर्षणं व्याख्यातम् ।)(III 309)

21 5 प्रधीनां सप्तधा विभागः । प्रधिमध्यमाः प्रक्रमव्यासा भवन्ति । (III 310)

21 6 यदतीरिक्तं सम्पद्यते तच्चतुरश्राणामध्यर्धाभिर्योयुज्येता । (III 312)

Indological Truths

21 7 अपरस्मिन्प्रस्तारे पादानां शिरोवद्विभागः शिरसः पादवत् । (III 312-13)

21 8 व्यत्यासं चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् । (III 314)

21 9 कूर्मस्यान्ते तनु पुरीषमुपदध्यान्मध्ये बहुलम् । (III 315-316), एतदेव द्रोणे विपरीतम् । (III 317)

21 10 अथ हैक एकविधप्रभृतीन्प्रौगादिन् ब्रूवते । (III 318)

21 11 समचतुरश्रानेक आचार्याः । (III 319), तस्य करण्या द्वादशेनेष्टकाः कारयेत्तासामर्ध्याः पाद्याश्च । (III 320)

21 12 अथाश्वमेधिकस्याग्नेः पुरुषाभ्यासो नारत्निप्रादेशानाम् । (III 321)

21 13 प्राकृतो वा त्रिगुण । त्रिस्तावोऽग्निर्भवतीत्येकविंशोऽग्निर्भवतीत्युभय ब्राह्मणमुभयं ब्राह्मणम् । (III 322)

□

ĀPASTAMBA-ŚULBSŪTRA

1

1 1 विहारयोगान् व्याख्यास्यामः ।

1 2 यावदायामं प्रमाणं तदर्धमभ्यस्यापरस्मिंस्तृतीये षड्भागोने लक्ष्मणं करोति । पृष्ठ्यान्तयोरन्तौ नियम्य लक्षणेन दक्षिणापायम्य निमित्त करोति । एवमुत्तरतो विपर्यस्येतरतः । स समाधिः । तन्निमित्तो निर्हासो विवृधिर्वा ।

1 3 आयामं वाभ्यस्यागन्तुच्चतुर्थमायामस्याक्ष्णयारज्जुः तिर्यङ्मानिशेषः । व्याख्यातं विहरणम् ।

1 4 दीर्घस्याक्षणयारज्जुः पार्श्वमानी तिर्यङ्मानी च यत्पृथग्भूते कुरुतस्तदुभय करोति । ताभिर्ज्ञेयाभिरुक्त विहरणम् ।

1 5 चतुरश्रस्याक्ष्णयारज्जुर्द्वित्तावर्तिं भूमिं करोति । समस्य द्विकरणी ।

1 6 प्रमाणं तृतीयेन वर्धयेत्तच्च चतुर्थेनात्मच्चतुस्तिशोऽनेन सविशेषः ।

1 7 अथापरम् । प्रमाणमात्री रज्जुमुभयतः पाश करोति । मध्ये लक्षणमर्धमध्ययोश्च पृष्ठ्यायां रज्जुमायम्य पाशयोर्लक्षणेष्विति शङ्कान् निहत्योपान्त्ययोः पाशौ प्रतिमुच्य मध्यमेन लक्षणेन दक्षिणापायम्य निमित्तं करोति । मध्यमे पाशौ प्रतिमुच्य उपर्युपरि निमित्तं मध्यमेन लक्षणेन दक्षिणापायम्य शङ्कुं निहन्ति । तस्मिन् पाश प्रतिमुच्य पूर्वस्मिन्नितर मध्यमेन लक्षणेन दक्षिणमशमायच्चेत् । उन्मुच्य पूर्वस्मादपरस्मिन् प्रतिमुच्य मध्यमेनैव लक्षणेन दक्षिणा श्रोणीमायच्चेत् । एवमुत्तरौ श्रोण्यशौ ।

Indological Truths

2

2 1 अथापरोयोगः । पृष्ठ्यान्तयोर्मध्ये च शङ्कून् निहत्यार्धे तद्विशेषमभ्यस्य लक्षणं कृत्वार्धमागमयेत् । अन्तयोः पाशौ कृत्वा मध्यमे सविशेषं प्रतिमुच्य पूर्वस्मिन्नितरं लक्षणेन कक्षिणमंसमायच्छेत् । उन्मुच्य पूर्वस्मादपरस्मिन् प्रतिमुच्य लक्षणेनैव दक्षिणां श्रोणीमायच्छेत् । एवमुत्तरौ श्रोण्यशौ ।

2 2 प्रमाणं तिर्यगद्विकरण्यायामस्तस्याक्ष्णयारज्जुस्त्रिकरणी ।

2 3 तृतीयकरण्येतेन व्याख्यात । विभागस्तु नवधा ।

2 4 तुल्ययोश्चतुरश्रयोरुक्तस्समासः । नाना प्रमाणयोश्चतुरश्रयोस्समासः । ह्रसीयसः करण्या वर्षीयसो वृद्ध्नं उल्लिखेत् । वृद्ध्नस्याक्ष्णयारज्जुरुभे समस्यति । तदुक्तम् ।

2 5 चतुरश्राच्चतुरश्र निर्जिहीर्षन् यावन्निर्जिहीर्षेत्तस्य करण्या वर्षीयसो वृद्ध्नमुल्लिखेत् । वृध्नस्य पार्श्वमानीमक्ष्णयेतरत्पार्श्वमुपसहरेत् । सा यत्र निपतेत्तदपच्छिन्द्यात् । छिन्नया निरस्तम् ।

2 6 उपसंहृता अक्ष्णयारज्जुस्सा चतुष्करणी छिन्ना चेतरा च यत्पृथग्भूते कुरुतः तदुभयं करोति । तिर्यङ्मानी पुरुषं शेषस्त्रीन् । तदुक्तम् ।

2 7 दीर्घचतुरश्र समचतुरश्रं चिकीर्षन् तिर्यङ्मान्या अपच्छिद्य शेष विभज्योभयत उपदध्यात् । खण्डमागन्तुना सम्पूरयेत् । तस्य निर्हरा उक्तः ।

3

3 1 समचतुरश्रं दीर्घचतुरश्रं चिकीर्षन यावच्चिकीर्षेत् तावतिं पार्श्वमानी कृत्वा यादधिक स्यात्तद्यथा योगमुपदध्यात् ।

3 2 चतुरश्रं मण्डलं चिकीर्षं मध्यात्कोट्यां निपातयेत् । पार्श्वतः परिकृष्यातिशयतृतीयेन सह मण्डलं परिलिखेत् । सा नित्या मण्डलम् । यावधीयते तावदागन्तु ।

3 3 मण्डल चतुरश्रं चिकीर्षं विष्कम्भं पञ्चदशभागान् कृत्वा द्वावुद्धरेत् । त्रयोदशावशिष्यन्ते । सानित्या चतुरश्रम् ।

3 4 प्रमाणेन प्रमाणं विधीयते ।

3 5 चतुरश्रं आदेशादन्यत् ।

3 6 द्वाभ्यां चत्वारि । त्रिभिर्नवा ।

3 7 यावत्प्रमाणा रज्जुस्तावतस्तावतो वर्गान् करोति । तथोपलब्धिः ।

3 8 अध्यर्धपुरुषा रज्जुरद्वौ सपादौ करोति । अर्धतृतीयोपुरुषा षट् सपादीन् ।

Indological Truths

3 9 अथात्यन्त प्रदेशः । यावता यावताऽधिकेन परिलिखति तत्पार्श्वयोरुपदधाति । यच्च तेन चतुरश्रं क्रियते तत्कोट्याम् ।

3 10 अर्धप्रमाणेन पादप्रमाणं विधीयते । अर्धस्य द्विप्रमाणायाः पादपूरणत्वात् । तृतीयेन नवमी कला ।

4

4 1 अग्न्याधेयिके विहारे गार्हपत्याहवनीययोरन्तराले विज्ञायते । अष्टासु प्रक्रमेषु ब्राह्मणोऽग्निमादधीत । एकादशसु राजन्यः । द्वादशसु वैश्यः ।

4 2 चतुर्विंशत्यामपरिमिते यावता वा चक्षुषा मन्यते तस्मान्नातिदूरमाधेय इति सर्वेषामविशेषेण श्रूयते ।

4 3 दक्षिणतः पुरस्ताद्वितृतीयदेशे गार्हपत्यस्य नेदीयसि दक्षिणाग्नेर्विज्ञायते ।

4 4 गार्हपत्याहवनीययोरन्तरालं पञ्चधा षड्धा वा संविभज्य षष्ठ सप्तम वा भागमागन्तुमुपसमस्या समं त्रैधं विभज्यापरस्मिस्तृतीये लक्षणं कृत्वा गार्हपत्याहवनीययोरन्तौ नियम्य लक्षणेन दक्षिणापायम्य निमित्तं करोति । तद्दक्षिणाग्नेरायतनम् । श्रुतिसामर्थ्यात् ।

4 5 यजमानमात्री प्रेच्यपरिमिता वा यथासन्नानि हवींषि सम्भवेदेवं तिरश्चिप्राञ्चौ वेद्यंसावुन्नयति । प्रतीची श्रोणी । पुरस्तादंहियसी पश्चात्प्रथीयसी मध्ये सन्नततरैवमिव हि योषेति दार्शिक्या वेदेर्विज्ञायते ।

4 6 अपरेणाहवनीयं यजमानमात्रं दीर्घचतुरश्रं विहृत्य तावती रज्जुमभ्यस्य मध्ये लक्षणं कृत्वा दक्षिणयोः श्रोण्यंसयोरन्तौ नियम्य लक्षणेन दक्षिणापायम्य निमित्त करोति । निमित्ते रज्जुं नियम्यान्तौ समस्येत् । दक्षिणायाः श्रोणेर्दक्षिणामसमालिखेत् । एवमुत्तरतः तिर्यञ्चानी द्विगुणां तथा कृत्वा पश्चात्पुरस्ताच्चोपलिखेत् । विमितायां पुरस्तात् पार्श्वमान्या उपसंहरेत् । श्रुतिसामर्थ्यात् ।

5

5 1 त्रिंशत्पदानि प्रक्रमा वा पश्चात्तिरश्ची भवति षट्त्रिंशत्प्राची चतुर्विंशतिः पुरस्तात्तिरश्चीति सौमिक्या वेदेर्विज्ञायते ।

5 2 षट्त्रिंशिकायामष्टादशोपसमस्या अपरस्मादन्ताद्द्वादशसु लक्षण पञ्चदशसु लक्षण पृष्ठ्यान्तयोरन्तौ नियम्य पञ्चदशिकेन दक्षिणापायम्य शङ्कुं निहन्त्येवमुत्तरतस्ते श्रोणी । विपर्यस्याशौ पञ्चदशिके नैवापायम्य द्वादशिके शङ्कुं निहन्ति । एवमुत्तरतस्तावशौ । तदेकरज्ज्वा विहरणम् ।

5 3 त्रिकचतुष्कयोः पञ्चिका क्षणयारज्जुः । ताभिस्त्रिरभ्यस्ताभिरशौ । चतुरभ्यस्ताभिः श्रोणी ।

5 4 द्वादशिकपञ्चिकयोस्त्रयोदशिका क्षणयारज्जुः ताभिरशौ द्विरभ्यस्ताभिः श्रोणी ।

Indological Truths

5 5 पञ्चदशिकाष्टिकयोः सप्तदशिका क्षणयारज्जुः ताभिः श्रोणी । द्वादशिकपञ्चत्रिंशिकयोस्सप्तत्रिंशिका क्षणयारज्जुः ताभिरंशौ ।

5 6 एतावन्ति ज्ञेयानि वेदिविहरणानि भवन्ति ।

5 7 अष्टाविंशत्यूनं पदसहस्रं महावेदिः । दक्षिणस्मादंशाद्द्वादशसु दक्षिणस्यां श्रोण्याम निपातयेत् । छेदं विपर्यस्येतरत उपदध्यात् । सा दीर्घचतुरश्रा । तथा युक्त सञ्चक्षीता ।

5 8 सौमिक्या वेदितृतीये यजेतेति सौत्रामण्या वेदेर्विज्ञायते । प्रक्रमस्य तृतीयकरणी प्रक्रमस्थानीया भवति । त्रिकरण्या वा अष्टक दशिके तिर्यञ्चान्यौ द्वादशिका पृष्ठ्या । (5 8), त्रीणि चतुर्विंशानि पदशतानि सौत्रामणीकी वेदिः । (5 9)

6

6 1 द्विस्तावा वेदिर्भवतीत्यश्वमेधे विज्ञायते । (5 10), प्रक्रमस्य द्विकरणी प्रक्रमस्थानीया भवति । (6 1)

6 2 प्रक्रमो द्विपदस्त्रिपदो वा । प्रक्रमे यथाकामी शब्दार्थस्य विशयित्वात् । यजमानस्याध्वर्योर्वा । एष हि चेष्टानां कर्ता भवति ।

6 3 रथमात्री निरूढपशुबन्धस्य वेदिर्भवतीति विज्ञायते । तत्र खल्वाहूरथाक्षमात्री पश्चात्तिर्यगीषया प्राची । विपथयुगेन पुरस्तात् । यावता वा बाह्ये छिद्रे ।

6 4 तदेकरज्ज्वोक्तं । पञ्चदशिकेनैवापायम्यार्धाक्षेणार्धयुगेनेति श्रोण्यंसान्निर्हरेत् ।

6 5 अथाप्युदाहरन्ति । अष्टाशीतिशतमीषा तिर्यगक्षश्चतुश्शतं षडशीतिर्युगं चास्य स रथश्चारण उच्यते । इति रथहपरिमाणम् ।

6 6 अरत्निभिर्वा चतुभिः पश्चात् षड्भिः प्राची त्रिभिः पुरस्तात् । तदेकरज्ज्वोक्तं पञ्चदशिकेनैवापायम्या द्वाभ्यामध्यर्धेनेति श्रोण्यंसान्निर्हरेत् ।

6 7 यजमानमात्री चतुःस्रक्तिर्भवतीति पैतृक्या वेदेर्विज्ञायते । तदेकरज्ज्वोक्त पञ्चदशिकेनैवापायम्यार्धेन ततश्श्रोण्यंसान्निर्हरेत् ।

6 8 दशपदोत्तरवेदिर्भवतीति सोमे विज्ञायते । तदेकरज्ज्वोक्तं पञ्चदशिकेनैवापायम्यार्धेन ततश्श्रोण्यंसान्निर्हरेत् ।

6 9 तां युगेन यजमानस्य वा पदैर्विमाय शम्यया पारिमिमीते ।

6 10 पदे युगेऽरत्नावियति शम्यायां च मानार्थेषु यथाकामी शब्दार्थस्य विशयित्वात् ।

6 11 विमितायां पुरस्तात्पार्श्वमान्यावुपसंहरेत् । श्रुतिसामर्थ्यात् ।

Indological Truths

7

7 1 नवारत्नि तिर्यक्सप्तविंशतिरुदगायतमिति सदसो विज्ञायते । (7 1), अष्टादशेत्येकेषाम् । (7 2), तदेकरज्ज्वोक्त पञ्चदशिकेनैवापायम्यार्धपञ्चमैः श्रोण्यसान्निर्हरेत् । (7 3)

7 2 प्रादेशमुखाः प्रादेशान्तराला भवन्तीत्युपरवाणां विज्ञायते । अरत्निमात्रं चतुरश्रं विहृत्य स्रक्तिषु शङ्कुन्निहत्यार्धप्रादेशेन तं परिलिखेत् श्रुतिसामर्थ्यात् । (7 4)

7 3 व्यायाममात्री भवतीति गार्हपत्यचितेर्विज्ञायते । (7 5), चतुरश्रेत्येकेषाम् । परिमण्डलेत्येकेषाम् । (7 6)

7 4 करणं व्यायामस्य तृतीयायामं सप्तमव्यासं कारयेत् । (7 7), ता एदविंशतिर्भवन्ति । (7 8), प्रागायामाः प्रथमे प्रस्तारेऽपरस्मिन्नुदगायामाः । (7 9)

7 5 मण्डलायां मृदो देहं कृत्वा मध्ये शङ्कुं निहत्यार्धव्यायामेन सह मण्डलं परिलिखेत् । तस्मिन् श्चतुरश्रमवदध्याद्यावत्सम्भवेत्तन्नवधा व्यवलिख्य त्रैधमेकैकं प्रधिक विभगजेत् । (7 10)

7 6 उपधाने चतुरश्रस्यावान्तरदेशान्प्रति स्रक्तीस्सम्पादयेत् । मध्यानीतरस्मिन्प्रस्तारे । व्यात्यास चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् । (7 11)

7 7 पिशीलमात्रा भवन्तीति धिष्ण्यानां विज्ञायते । (7 12); चतुरश्रा इत्येकेषाम् । परिमण्डला इत्येकेषाम् । (7 13)

7 8 मृदो देहान्कृत्वा अग्नीध्रियं नवधा व्यवलिख्य एकस्यास्थानेऽस्मानमुपदध्यात् । (7 14), यथासङ्ख्यमितरान्व्यवलिख्य यथायोगमुपदध्यात् । (7 15)

8

8 1 भवतीव खलु वा एष योऽग्निं चिनुत इति विज्ञायते । वयसां वा एष प्रतिमया चीयत इत्याकृतिचोदना प्रत्यक्षविधानाद्वा ।

8 2 यावदाम्नातेन वेणुना चतुर आत्मनि पुरुषानवमिमीते । पुरुषं दक्षिणे पक्षे पुरुषं पुच्छे पुरुषमुत्तरे । अरत्निना दक्षिणतो दक्षिण पक्षं वर्धयति । एवमुत्तरत उत्तरम् । प्रादेशेन वितस्त्या वा पश्चात् पुच्छम् ।

8 3 एकविधः प्रथमोऽग्निर्द्विविधः द्वितीयस्त्रिविधस्तृतीयः । त एवमेव आद्यन्त्यैकशतविधात् ।

8 4 तदु ह वै सप्तविधमेव चिन्वीत । सप्तविधो वाव प्राकृतोऽग्निः । तत ऊर्ध्वमेकोत्तरानिति विज्ञायते ।

8 5 एदविधप्रभृतीनां न पक्षपुच्छानि भवन्ति । सप्तविधवाक्यशेषत्वाच्छ्रुतिविप्रतिषेधाच्च ।

8 6 अष्टविधप्रभृतीनां यदन्यत्सप्तभ्यस्तत्सप्तधा विभज्य प्रतिपुरुषमावशयेत् । आकृतिविकारस्या-श्रुतत्वात् ।

8 7 पुरुषमात्रेण विमिमीते वेणुना विमिमीते इति विज्ञायते ।

Indological Truths

9

9 1 यावान्यजमान ऊर्ध्वबाहुस्तावदन्तराले वेनोश्छिद्रे करोति मध्ये तृतीयम् । अपरेण यूपावटदेशमनुपृष्ठ्यं वेणुं निधाय छिद्रेषु शङ्कून्निहत्य उन्मुच्यापराभ्यां दक्षिणाप्राक्परिलिखेद् अन्तात् । उन्मुच्य पूर्वस्मादपरस्मिन्प्रतिमुच्य दक्षिणा प्रत्यक्परिलिखेदन्तात् । (8 8) उन्मुच्य वेणु मध्यमे शङ्कावन्त्यं वेणोश्छिद्रं प्रतिमुच्योपर्युपरिलेखासमरं दक्षिणा वेणु निधायान्ते छिद्रे शङ्कु निहत्य तस्मिन्मध्यमं वेणोश्छिद्रं प्रतिमुच्य लेखान्तयोरितरे प्रतिष्ठाप्य छिद्रायोश्शङ्कू निहन्ति । स पुरुषश्चतुरश्रः । (9 1)

9 2 एवं प्रदक्षिण चतुर आत्मनि पुरुषानवमिमीते । पुरुषं दक्षिणे पक्षे पुरुषं पुच्छे पुरुषमुत्तरे । अरत्निना दक्षिणतो दक्षिणमित्युक्तम् ।

9 3 पृष्ठ्यातो वा पुरुषमात्रस्याक्ष्णया वेणुं निधाय पूर्वस्मिन्नितरम् । ताभ्यां दक्षिण अंसं निर्हरेत् । विपर्यस्य श्रोणी । पूर्ववदुत्तरमसम् ।

9 4 रज्ज्वा वा विमायोत्तरवेदिन्यायेन वेणुना विमिमीते ।

9 5 सपक्षपुच्छेषु विधाभ्यसेऽपचये च विधासप्तमकरणी पुरुषस्थानीयां कृत्वा विहरेत् ।

9 6 करणानीष्टकाना पुरुषस्य पञ्चमेन कारयेत् । तासामेवैकतोऽध्यर्धास्तद्द्वितीयम् । पुरुषस्य पञ्चमो भाग एकतः प्रादेश एकतः तत्तृतीयम् । सर्वतः प्रादेशस्तच्चतुर्थम् । समचतुरश्रः पञ्चदशभागीयास्तत्पञ्चमम् ।

9 7 ऊर्ध्वप्रमाणमिष्टकाना जानोः पञ्चमेन कारयेदर्धेन नाकसदा पञ्चचोडानां च ।

9 8 यत्पच्यमानानां प्रतिह्रसेत पुरीषेण तत्सम्पूरयेदनियतपरिमाणत्वात् पुरीषस्य ।

10

10 1 उपधानेऽध्यर्धा दश पुरस्तात् प्रतीचीरात्मन्युपदधाति । दश पश्चात्प्रतीचीः । पञ्च पञ्च पक्षाग्रयोः । पक्षाप्ययोश्च विशयाः तासामर्धेष्टकामात्राणि पक्षयोर्भवन्ति । पञ्च पञ्च पुच्छापर्श्वयोर्दक्षिणा । उदीचीश्च ।

10 2 पुच्छे प्रादेशमुपधाय सर्वमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् ।

10 3 पञ्चदशभागीयाभिः सङ्ख्या पूरयेत् ।

10 4 अपरस्मिन्प्रस्तारेऽध्यर्धा दश दक्षिणत उदीचीरात्मन्युपदधाति । दशोत्तरतो दक्षिणा । यथा प्रथमे प्रस्तारे पक्षौ तथा पुच्छम् । यथा पुच्छं तथा पक्षौ । विपरीता अप्याये ।

10 5 सर्वमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् ।

10 6 पञ्च चितयो भवन्ति । पञ्चभिः पुरीषैरभ्यूहतीति पुरीषान्ता चितिः अर्थान्तरत्वात्पुरीषस्य ।

Indological Truths

10 8 जानुदघ्नं साहस्रं चिन्वीत प्रथमं चिन्वानः । नाभिदघ्नं द्विषाहस्रं द्वितीयमास्यदघ्नं त्रिषाहस्र तृतीयमुत्तरमुत्तरं ज्यायांसम् । महान्तं बृहन्तमपरिमितं स्वर्गकामश्चिन्वीतेति विज्ञायते ।

10 9 द्विषाहस्रे द्विप्रस्ताराश्चितयो भवन्ति । त्रिषाहस्र त्रिप्रस्ताराश्चतुर्थप्रभृतिष्वाहारेषु नित्यमिष्टका परिमाणम् ।

10 10 विज्ञायते च न ज्यायांसं चित्वा कनीयांसं चिन्वीतेति ।

11

11 1 चतुरश्राभिरग्निं चिनुत इति विज्ञायते । समचतुरश्रा अनुपपदत्वाच्छब्दस्य ।

11 2 पादमात्र्यो भवन्ति अरत्निमात्र्यो भवन्त्यूर्वस्थिमात्र्यो भवन्त्यणूकामात्र्यो भवन्तीति विज्ञायते ।

11 3 चतुर्भागीयमणूकम् । पञ्चम भागीयारत्निः । तथोर्वस्थि ।

11 4 पादेष्टका पादमात्री । तत्र यथाकामी शब्दार्थस्य विशयित्वात् ।

11 5 सन्ध्यन्तराले पञ्चभागीयास्सपादाः ।

11 7 पुच्छे प्रादेशमुपधाय सर्वमग्निं चतुर्भागीयाभिः प्रच्छादयेत् ।

11 8 पादेष्टकाभिः सङ्ख्यां पूरयेत् ।

11 9 अपरस्मिन्प्रस्तारे पुच्छाप्यये पञ्चमभागीय विशयाः । ता आत्मनि चतुर्दशभिः पादैर्यथायोगं उपदध्यात् ।

11 10 सर्वमग्निं पञ्चमभागीयाभिः प्रच्छादयेत् ।

11 11 पादेष्टकाभिः सङ्ख्यां पूरयेत् । व्यत्यासं चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् ।

12

12 1 एकविधप्रभृतीनां करणीनां द्वादशेन त्रयोदशेनेतिष्टकाः कारयेत् । पादेष्टकाश्च । व्यत्यास चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् ।

12 2 एकविधप्रभृतीनां प्रथमाहारेण द्वितीयेन तृतीयेनेति योयुज्येत । सर्वेषां यथा श्रुतिसङ्ख्या तथोर्ध्वप्रमाणम् ।

12 3 काम्या गुणविकाराः गुणशास्त्रत्वात् ।

12 4 प्रौगं चिन्वीत भ्रातृव्यवानीति विज्ञायते ।

12 5 यावानग्निः सारत्निप्रादेशो द्विस्तावतिं भूमिं चतुरश्रं कृत्वा पूर्वस्याः करण्या अर्धाच्छ्रोणी प्रत्यालिखेत् । सा नित्या प्रौगम् ।

Indological Truths

12 6 करणानि चयनमित्येकविधोक्तम् । प्रौगा इष्टकाः कारयेत् ।

12 7 उभयतः प्रौग चिन्वीत यः कामयेत प्रजातान् भ्रातृव्यान्नुदेय प्रतिजनिष्यमाणानिति विज्ञायते ।

12 8 यथा विमुखे शकटे । (12 8), तावदेव दीर्घचतुरश्र विहृत्य पूर्वापरयोः करण्योरर्धात्तावति दक्षिणोत्तरयोर्निपातयेत् । सा नित्योभायतः प्रौगम् । (12 9), प्रौगचितोक्तम् । (12 10)

12 9 रथचक्रचितं चिन्वीत भ्रातृव्यवानीति विज्ञायते । (12 11)

12 10 यावानग्निः सारत्निप्रादेशस्तावती भूमिं परिमण्डलां कृत्वा त्समिंश्चतुरश्र अवदध्याद्यावत्सम्भवेत् । (12 12)

13

13 1 तस्य करण्या द्वादशेनेष्टकाः कारयेत् ।

13 2 तासां षट्प्रधावुपधाय शेषमष्टधा विभजेत् ।

13 3 उपधाने चतुरश्रस्यावान्तरदेशान प्रतिरक्तीस्सम्पादयेत् । मध्यानीतरस्मिन् प्रस्तारे । व्यत्यास चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् ।

13 4 द्रोणचितं चिन्वीतान्नकाम इति विज्ञायते ।

13 5 द्वयानि तु खलु द्रोणानि चतुरश्राणि परिमण्डलानि च ।

13 6 तत्र यथाकामी शब्दार्थ्यस्य विशयित्वात् ।

13 7 चतुरश्रं वा यस्य गुणशास्त्रम् । (13 7), स चतुरश्रः । (13 8)

13 8 पश्चात्त्सरुर्भवत्यनुरूपत्वायेति विज्ञायते । (13 9)

13 9 सर्वस्या भूमेर्दशम त्सरुः । तस्य पुच्छेन निर्हार उक्तः । (13 10)

13 10 तस्य करण्या द्वादशेनेष्टकाः कारयेदध्यर्धाः पादेष्टकाश्च । (13 11)

13 11 उपधानेऽध्यर्धः पुरस्तात्प्रतीचिरात्मन्युपदधाति । त्सर्वगरे श्रोण्योश्च प्राचीः । (13 12)

13 12 सर्वमग्निं चतुरश्राभिः प्रच्छादयेत् । (13 13)

13 13 पादेष्टकाभिः सङ्ख्यां पूरयेत् । (13 14)

14 14 अपरस्मिन्प्रस्तारेऽध्यर्धा दक्षिणत उदीचीरात्मन्युपदधात्युत्तरतश्च दक्षिणाः । त्सरुपार्श्वयोर्दक्षिणा उदीचीश्च । (13 15)

13 15 सर्वमग्निं चतुरश्राभिः प्राच्छादयेत् । (13 16)

13 16 पादेष्टकाभिः सङ्ख्यां पूरयेत् । (13 17), व्यत्यासं चिनुयाद्यावतः प्रस्तारंश्चिकीर्षेत् । (13 6)

Indological Truths

14

14 1 समूह्यं चिन्वीत पशुकाम इति विज्ञायते ।

14 2 समूहन्निवेष्टका उपदधाति ।

14 3 दिक्षु चात्वाला भवन्ति । तेभ्यः पुरीषमभ्युहतीति विज्ञायते ।

14 4 परिचाय्यं चिन्वीत ग्रामकाम इति विज्ञायते ।

14 5 मध्यमां स्वयमातृण्णां प्रदक्षिणमिष्टकागणैः परिचिनोति । स परिचाय्यः ।

14 6 उपचाय्यं चिन्वीत ग्रामकाम इति विज्ञायते । (14 6), परिचाय्येनोक्तः । (14 7)

14 7 श्मशानचितं चिन्वीत यः कामयेत पितृलोक ऋध्नुयामिति विज्ञायते । (14 8)

14 8 द्वयानि तु खलु श्मशानानि चतुरश्राणि परिमण्दलानि च । (14 9)

14 9 तत्र यथाकामी शब्दार्थस्य विशयित्वात् । (14 10)

14 10 चतुरश्रं वा यस्य गुणशास्त्रम् । (14 11), स चतुरश्रः । त्सरुवर्जं द्रोणचितोक्तः । (14 12)

14 11 छन्दश्चितं चिन्वीत पशुकाम इति विज्ञायते । (14 13)

14 12 सर्वैश्छन्दोभिश्चिनुयादित्येकम् । प्राकृतैरित्यपरम् । (14 14)

15

15 1 श्येनचितं चिन्वीत सुवर्गकाम इति विज्ञायते ।

15 2 वक्रपक्षो व्यस्तपुच्छो भवति । पश्चात्प्राङुदूहति । पुरस्तात्प्रत्यङुदूहति । एवमिव हि वयसां मध्ये पक्षनिर्णामो भवतीति विज्ञायते ।

15 3 यावानग्निः सारत्निप्रदेशः सप्तविधः सम्पद्यते । प्रादेशं चतुर्थमात्मनश्चतुर्भागीयाश्चष्टौ । तासां तिस्रः तिस्रः शिरः । इतरत्पक्षयोर्विभजेत् ।

15 4 पञ्चारत्निः पुरुषः । चतुररत्निर्व्यायामः । चतुर्विंशत्यङ्गुलयोऽरत्निः । तदर्धं प्रादेश इति क्लृप्तिः ।

15 5 अर्धदशमा अरत्नयोऽङ्गुलयश्च चतुर्भागोन पक्षायामः ।

15 6 द्विपुरुषां रज्जुमुभयतः पाशं करोति मध्ये लक्षणम् । पक्षस्यापरयोः कोट्योरन्तौ नियम्य लक्षणेन प्राचीनमायच्छेदेवं पुरस्तात् । स निर्णामः । (15 6), एतेनोत्तरः पक्षो । व्याख्यातः । (15 7)

15 7 आत्मा द्विपुरुषायामोऽध्यर्धपुरुषव्यासः । (158)

15 8 पुच्छेऽर्धपुरुषव्यासं पुरुषं प्रतीचीनमायच्छेत् । तस्य दक्षिणतोन्यमुत्तरतश्च । तावक्ष्णया व्यवलिखेत् । यथाऽर्धपुरुषोऽप्ययेस्यात् । (15 9)

15 9 शिरस्यर्धपुरुषेण चतुरश्र कृत्वा पूर्वस्याः करण्या अर्धात्तावति दक्षिणोत्तरयोर्निपातयेत् । (15 10)

Indological Truths

16

16 1 अप्ययान्नति श्रोण्यसानपच्छिन्द्यात् । एवमिव हि श्येनः ।

16 2 करणं पुरुषस्य पञ्चमायाम षष्ठव्यासं कारयेद्यथायोगनत तत्प्रथमम् ।

16 3 ते द्वे प्राची संहिते । तद्द्वितीयम् ।

16 4 प्रथमस्य षड्भागमष्टमेभागेन वर्धयेत् । यथायोगनतं तत्तृतीयम् ।

16 5 चतुर्भागीयाऽध्यर्धा । तस्याश्चतुर्भागीयामात्रमक्ष्ण्या भिन्द्यात् । तच्चतुर्थम् ।

16 6 चतुर्भागीयार्धं पञ्चमम् ।

16 7 तस्याक्ष्णया भेदः षष्ठम् ।

16 8 पुरुषस्य पञ्चम भाग दशभागव्यासं प्रतीचीनमायच्छेत् । तस्य दक्षिणतोऽन्यमुत्तरतश्च । तावक्ष्णया दक्षिणापरयोः कोट्योरालिखेत् । तत्सप्तमम् ।

16 9 एवमन्यत् । उत्तरं तूत्तरस्याः कोट्यालिखेत् तदष्टमम् ।

16 10 चतुर्भागीयाक्ष्णयोभयतो भेदो नवमम् ।

16 11 उपधाने षष्टिः षष्टिः पक्षयोः प्रथमा उदीचीरुपदध्यात् ।

16 12 पुच्छपार्श्वयोरष्टावष्टौ षष्ठ्ययस्तिस्रोऽग्रे तत एकां ततस्तिस्रः तत एकाम् ।

16 13 पुच्छाप्यये चतुर्थ्यौ विशये । तयोश्च पश्चात्पञ्चम्यावनीकसंहिते ।

17

17 1 शेषे दश चतुर्थ्यः श्रोण्यंशेषु चाष्टौ प्राचीः प्रतीचीश्च ।

17 2 शेषे च षड्विंशतिरष्टौ षष्ठ्यस्त्वतस्रः पञ्चम्यः ।

17 3 शिरसि चतुर्थ्यौ विशये । तयोश्च पुरस्तात्प्राच्यौ ।

17 4 एष द्विशतः प्रस्तारः ।

17 5 अपरस्मिन्प्रस्तारे पञ्च पञ्च निर्णामयोर्द्वितीयाः । अप्ययोश्च तृतीया आत्मानमष्टभागावेताः । शेषे पञ्चचत्वारिंशत् प्रथमाः प्राचीः ।

17 6 पुच्छपार्श्वयोः पञ्च पञ्च सप्तम्यः । द्वितीयचतुर्थ्योश्चान्यतरतः प्रतीसहितामेकैकां । शेषे त्रयोदशाष्टम्यः ।

17 7 श्रोण्यंशेषु चाष्टौ चतुर्थ्यो दक्षिणा उदीचीश्च । शेषे च विंशतिस्त्रिंशत् षष्ठ्य एक पञ्चमीम् ।

17 8 शिरसि चतुर्थ्यौ तयोश्च पुरस्ताच्चतस्रो नवम्यः ।

Indological Truths

17 9 एष द्विशतप्रस्तारः ।

17 10 व्यत्यासं चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् ।

18

18 1 श्येनचितं चिन्वीत सुवर्गकाम इति विज्ञायते ।

18 2 वक्रपक्षो व्यस्तपुच्छो भवति । पश्चातप्राङुदूहति । पुरस्तात्प्रत्यङुदूहति । एवमिवहि वयसां मध्ये पक्षनिर्णामो भवतीति विज्ञायते ।

18 3 पुरुषस्य षोडशिभिर्विंशशतं सारत्निप्रादेशः सप्तविधः सम्पद्यते । तासां चत्वारिंशदात्मनि तिस्रः शिरसि पञ्चदश पुच्छे एकत्रिंशद्दक्षिणे पक्षे तथोत्तरे ।

18 4 अध्यर्धपुरुषस्तिर्यग्द्वावायामत इति दीर्घचतुरश्रं विहृत्य श्रोण्यंसेभ्यो द्वे द्वे षोडश्यौ निरस्येत् । चत्वारिंशत्परिशिष्यन्ते । स आत्मा ।

18 5 शिरस्यर्धपुरुषेण चतुरश्रं कृत्वा पूर्वस्याः करण्या अर्धात्तावती दक्षिणोत्तरयोर्निपातयेत् । तिस्रः परिशिष्यन्ते तच्छिरः ।

18 6 पुरुषस्तिर्यग्द्वावायामतः षोडशभागश्च दक्षिणः पक्षः । तथोत्तरः ।

18 7 पक्षाग्रे पुरुषचतुर्थेन चत्वारि चतुरश्राणि कृत्वा तान्यक्ष्णया व्यावलिख्यार्धानि निरस्येत् । एकत्रिंशत्परिशिष्यन्ते ।

18 8 पक्षाग्रमुत्सृज्य मध्ये पक्षस्य प्राची लेखामालिखेत् । पक्षाप्यये पुरुषं नियम्य पुरुषान्ते नितोद कुर्यात् । नितोदात्प्राचीनं पुरुषान्ते नितोदं नितोदयोर्नानान्तावालिखेत् । तत्पक्ष नमनम् । एतेनोत्तरः पक्षो व्याख्यातः ।

19

19 1 द्विपुरुषं पश्चादर्धपुरुषं पुरस्ताच्चतुर्भागोनः पुरुष आयामोऽष्टादशकरण्यौ पार्श्वयोस्ताः पञ्चदश परिगृह्णन्ति । तत्पुच्छम् ।

19 2 षोडशिं चतुर्भिः परिगृह्णीयात् । अष्टमेन त्रिभिरष्टमैश्चतुर्थेन चतुर्थसविशेषेनेति ।

19 3 अर्धेष्टकां त्रिभिर्द्वाभ्या चतुर्थाभ्यां चतुर्थसविशेषेनेति ।

19 4 पादेष्टकां त्रिभिश्चतुर्थेनैक चतुर्थसविशेषार्धाभ्यां चेति ।

19 5 पक्षेष्टकां चतुर्भिर्द्वाभ्यां चतुर्थाभ्यां सप्तमाभ्यां चेति ।

19 6 पक्षमध्यीयां चतुर्भिर्द्वाभ्यां चतुर्थाभ्या द्विसप्तमाभ्यां चेति ।

Indological Truths

19 7 पक्षाग्रीयां त्रिभिश्चतुर्थेनैकं चतुर्थसप्तमाभ्यामेक चतुर्थसविशेषसप्तमाभ्या चेति ।

19 8 पक्षकरण्याः सप्तमं तिर्यङ्मानी पुरुषचतुर्थं च पार्शिवमानि । तस्याक्ष्णयारज्ज्वा करणं प्रजृम्भयेत् । पक्षनमन्याः सप्तमेन फलकानि नमयेत् ।

19 9 उपधाने चतस्रः पादेष्टकाः पुरस्ताच्छिरसि । अपरेण शिरसोऽप्ययं पञ्च । पूर्वेण पक्षाप्ययावेकादश । अपरेणैकादश पूर्वेण पुच्छाप्ययं पञ्चापरेण पञ्च पञ्चदश पुच्छाग्रे ।

20

20 1 चतस्रश्चतस्रः पक्षाग्रीयाः पक्षाग्रयोः पक्षाप्ययययोश्च विशयाः ।

20 2 ता आत्मनि चतसृभिश्चतसृभिः षोडशिभिर्यथायोग पर्युपदध्यात् ।

20 3 चतस्रश्चतस्रः पक्षमध्यीयाः पक्ष मध्ययोः । (20 3), पक्षेष्टकाभिः प्राचीभिः पक्षौ प्रच्छादयेत् । (20 4)

20 4 अवशिष्टं षोडशिभिः प्रच्छादयेत् । अन्त्या बाह्यविशेषा अन्यत्र शिरसः । (20 5)

20 5 अपरस्मिन्त्रस्तारे पुरस्ताच्छिरसि द्वे षोडश्यौ बाह्यविशेषे उपदध्यत् । तेऽपारेण द्वे विशये अभ्यन्तरविशेषे । (20 6)

20 6 द्वाभ्यामर्धेष्टकाभ्यां यथायोगं पर्युपदध्यात् । बाह्यविशेषाभ्यां परिगृह्णीयात् । (20 7)

20 7 आत्मा करणीनां सन्धिषु षोडश्यो बाह्यविशेषा उपदध्यात् । (20 8)

20 8 चतस्रश्चतस्रोऽर्धेष्टकाः पक्षाग्रयोः । पक्षेष्टकाभिरुदीचीभिः पक्षौ प्रच्छादयेत् । (20 9)

20 9 तिस्रस्तिस्रोऽर्धेष्टकाः पुच्छपार्श्वयोः । (20 10)

20 10 अवशिष्ट षोडशिभिः प्रच्छादयेत् । अन्त्या बाह्यविशेषा अन्यत्र पुच्छात् । (20 11)

20 11 यच्चतुरस्रं त्र्यश्रं वा सम्पद्येतार्धेष्टकाभिः पादेष्टकाभिर्वा प्रच्छादेयत् । (20 12), अणुकाः पञ्चदशभागीयानां स्थाने । (20 13)

20 12 व्यत्यासं चिनुयाद्यावतः प्रस्तारांश्चिकीर्षेत् । (20 14)

21

21 1 कङ्कचिदेतजचिदिति श्येनचिता व्याख्यातौ ।

21 2 एवमिव हि श्येनस्य वर्षीयांसौ पक्षौ पुच्छाद्वक्रौ सन्नत पुच्छं दीर्घ आत्मा मण्डलः शिरश्च । तस्माच्छ्रुतिसामर्थ्यात् । अशिरस्को वाऽनामनानात् ।।

21 3 विज्ञायते च । कङ्कचितं शीर्षण्वन्तं चिन्वीत यः कामयेत सशीर्षोऽमुष्मिन्लोके सम्भवेयमिति विद्यमाने केतं ब्रूयात् ।

Indological Truths

21 4 प्रकृतौ वक्रौ पक्षौ सन्नतं पुच्छ विकारश्रवणाद्यथाप्रकृत्यात्मा विकारै।

21 5 यथो एतच्छ्येनचित चिन्वीतेति यावदाम्नातं सारूप्य तद्व्याख्यातम्।

21 6 त्रिस्तावोऽग्निर्भवतीत्यश्वमेधे विज्ञायते।

21 7 तत्र सर्वाभ्यसोऽविशेषात्।

21 8 दीर्घचतुरश्राणां समासेन'पक्षपुच्छानां समास उक्तः।

21 9 एकविंशोऽग्निर्भवतीत्यश्वमेधे विज्ञायते।

21 10 तत्र पुरुषाभ्यासो नारत्निप्रादेशानां सङ्ख्यासंयोगात् सङ्ख्यासंयोगात्।

□

KĀTYĀYAN-ŚULBSŪTRA

1

1 1 रज्जुसमासं वक्ष्यामः।

1 2 समे शङ्कुं निखाय शङ्कुसम्मितया रज्ज्वा मण्डलं परिलिख्य यत्र लेखयोः शङ्कग्रच्छाया निपतति तत्र शङ्कु निहन्ति सा प्राची। तदन्तरं रज्ज्वाभ्यस्य पाशौ कृत्वा शङ्कोः पाशौ प्रतिमुच्य दक्षिणायम्य मध्ये शङ्कुमेवमुत्तरतः सोदीचि।

1 3 रज्ज्वन्तयोः पाशौ करोति। श्रोण्यंसनिरञ्छनसङ्ख्यासमासोभङ्गेषु लक्षणानि। प्राच्यन्तयोः शङ्कू निहन्ति। श्रोण्योरंसयोश्च। शङ्कोः पाशौ प्रतिमुच्य निरञ्छनेन गृहीत्वा दक्षिणपूर्वां दिशं हरन्ति। एवमुत्तरतः। विपर्यस्येतरतः। स समाधिः सर्वत्र।

1 4 प्रमाणमभ्यस्याभ्यासचतुर्थे लक्ष्णं करोति तन्निरञ्छनम्। अक्ष्णया तिर्यङ्मानिशेषः।

1 5 प्रमाणार्धं वाभ्यस्याभ्यासषष्ठे लक्षणं करोति तन्निरञ्छनम्। अक्ष्णया तिर्यङ्मानीशेषः।

1 6 प्रमाणार्धे समचतुरश्रस्य शङ्कुः। शास्त्रवदर्धे दीर्घचतुरश्रस्य। शकटमुखस्य चैवम्।

1 7 एतेन प्राग्वंशवेदिमानानि व्याख्यातानि। शालामानं च। तत्रोदीची प्राचीनात्। सदसश्चैवम्।

1 8 अपरिमितं प्रमाणाद्भूयः।

1 9 प्रमाणे शास्त्रं प्रमाणं निर्हासविवृद्ध्योः। योगश्च।

1 10 इतरस्यवितृतीये दक्षिणत इत्येतद्वक्ष्यामः। गार्हपत्याहवनीययोरन्तरालं षढ्धा सप्तधा वागन्तुसम त्रेधा विभज्यापरवितृतीयलक्षणेन दक्षिणायम्य तस्मिन्नग्निः। विपर्यस्योत्तरत उत्करः।

1 11 अपवान्तरत्रिभागोऽनया रज्ज्वा पूर्वार्धे समचतुरश्रं कृत्वा श्रोण्यामग्निः। विपर्यस्योत्तरास उत्करः।

Indological Truths

2

2 1 अङ्गुलै रथसम्मितायाः प्रमाणम् । तत्राष्टाशितिशतमीषा । चतुःशतमक्षः । षोडशीतिर्युगम् । चत्वारोऽष्टकाः शम्या ।

2 2 पैतृक्यां द्विपुरुषं समचतुरश्रं कृत्वा करणीमध्ये शङ्कवः स समाधिः ।

2 3 करणी तत्करणी तिर्यङ्मानी पार्श्वमान्यक्ष्णया चेति रज्ज्वः ।

2 4 पदं तिर्यङ्मानी त्रिपदा पार्श्वमानी तस्याक्ष्ण्या रज्जुर्दशकरणी ।

2 5 एवं द्विपदा तिर्यङ्मानी षट्पद पार्श्वमानी तस्याक्ष्णया रज्जुश्चत्वारिंशत्करणी ।

2 6 उपदिष्ट युगप्रमाणं शम्याप्रमाणं च दर्शनात् ।

2 7 दीर्घचतुरश्रस्याक्ष्णया रज्जुस्तिर्यङ्मानी पार्श्वमानी च यत्पृथग्भूते कुरुतस्तदुभयं करोतीति क्षेत्रज्ञानम् ।

2 8 समचतुरश्रस्याक्ष्णया रज्जुर्द्विकरणी ।

2 9 करणी तृतीयेन वर्धयेत्तच्च स्वचतुर्थेनात्मचतुस्त्रिंशोऽनेन सविशेष इति विशेषः ।

2 10 प्रमाणं तिर्यक् द्विकरण्यायामस्तस्याक्ष्णया रज्जुस्त्रिकरणी ।

2 11 तृतीयकरण्येतेन व्याख्याता । प्रमाणविभागस्तु नवधा करणीतृतीयं नवभागः । नवभागास्त्रयस्तृतीयकरणी ।

2 12 सौत्रामण्यां प्रक्रमार्था । तृतीयकरणी समासार्था ।

2 13 तुल्यप्रमाणानां समचतुरश्राणामुक्तः समाश्च । नानाप्रमाणसमासे ह्रसीयासः करण्या वर्षीयसोऽपच्छिन्द्यात्तस्याक्ष्णया रज्जुरुभे समस्यतीति समासः ।

3

3 1 चतुरश्राच्चतुरश्रं निर्जिहीर्षन् यावन्निर्जिहीर्षेत्तावदुभयतोऽपच्छिद्य शङ्कू निखाय पार्श्वमेनिं कृत्वा पार्श्वमानीसम्मितामक्ष्णया तत्रोपसंहरति, स समासेऽपच्छेदः, सा करण्येषा निर्ह्रासः ।

3 2 दीर्घचतुरश्रं समचतुरश्रं चिकीर्षन मध्ये तिर्यगपच्छिद्यान्यतरद्विभज्येतरत्पुरस्ताद्दक्षिणतश्चोप दध्याच्छेषमागन्तुना पूरयेत्तस्योक्तो निर्ह्रासः ।

3 3 अतिदीर्घं चेत्तिर्यङ्मान्यापच्छिद्यापच्छिद्यैकसमासेन समस्या शेषं यथायोगमुपसंहरेदित्येकः समासः ।

3 4 समचतुरश्रं दीर्घचतुरश्रं चिकीर्षन् मध्येऽक्ष्णया पच्छिद्या तच्च विभज्यान्यतरत्पुरस्तादुत्तरतश्च पदध्याद्विषमं चेद्यथायोगमुपसंहरेदिति व्यासः ।

Indological Truths

3 5 प्रमाणं चतुरश्रमादेशादन्यत् ।

3 6 द्विप्रमाणा चतुःकरणी त्रिप्रमाण नवकरणी चतुःप्रमाणा षोडशकरणी ।

3 7 यावत्प्रमाणा रज्जुर्भवति तावन्तस्तावन्तो वर्गा भवन्ति तान्समस्येत् ।

3 8 अर्धप्रमाणेन पादप्रमाणं विधीयते । तृतीयेन नवमोंऽशः । चतुर्थेन षोडशी कला ।

3 9 एष निर्हसस्तस्य पुरस्तादुक्त शास्त्रम् ।

3 10 यावत्प्रमाणा रज्जुर्भवतीति विवृद्धे ह्रासो भवति ।

3 11 चतुरश्रं मण्डलं चिकीर्षन्मध्यादंसे निपात्य पार्श्वतः परिलिख्य तत्र यदतिरिक्तं भवति तस्य तृतीयेन सह मण्डलं परिलिखेत् स समाधिः ।

3 12 मण्डलं चतुरश्रं चिकीर्षन् विष्कम्भ पञ्चदशभागा कृत्वा द्वावुद्धरेच्छेषः करणी ।

4

4 1 द्रोणचिद्रथचक्रचित्कङ्कचित्प्रौगचिदुभयतः प्रौगः समुह्यपुरीष इत्यग्नयः ।

4 2 द्रोणे यावानग्निः सपक्षपुच्छविशेषस्तावच्चतुरश्रं कृत्वा द्रोणदशमविभागे वृत्तमित्येके । तद्दशमेनापच्छिद्यापच्छिद्यैकसमासेन समस्य निर्हृत्य सर्वमग्निं तथाकृतिं कृत्वा पुरस्तात्पश्चाद्वोप दध्यात् । मण्डलेऽप्येवम् ।

4 3 प्रौगे यावानग्निः सपक्षपुच्छविशेषस्तावद्द्विगुणं चतुरश्रं कृत्वा यः पुरस्तात्करणीमध्ये शङ्कुर्यौ च श्रोण्योः सोऽग्निः ।

4 4 उभयतः प्रौगे तावदेव दीर्घचतुरश्रं कृत्वा करणीमध्येषु शङ्कवः स समाधिः ।

4 5 प्रौगं चतुरश्रं चिकीर्षन्मध्ये प्राञ्चमपच्छिद्य विपर्यस्येतरत उपधाय दीर्घचतुरश्रसमासेन समस्येत् स समाधिः ।

4 6 उभयतः प्रौगं चेन्मध्ये तिर्यगपच्छिद्य पूर्ववत्समस्येत् ।

4 7 एतेनैव त्रिकर्णसमासो व्याख्यातः । पञ्चकर्णाना च । प्रौगेऽपच्छिद्यैककर्णानाम् । द्विकर्णाना समचतुरश्रेऽपच्छिद्य ।

5

5 1 उत्तरेषु पुरुषोच्चयेनैकशतविधादित्येतद्वक्ष्यामः ।

5 2 आद्योऽग्निर्द्विगुणस्त्रिगुणो भवतीति सर्वसमासः ।

5 3 एकविंशतिविधो भवतीति पुरुषाभ्यासः ।

Indological Truths

5 4 पुरुषाभ्यासे यावानग्निः सपक्षपुच्छविशेषस्तावच्चतुरश्र कृत्वा त्समिन्पुरुषप्रमाणमवदध्यात् ।

5 5 समस्तं पञ्चदशभागान्कृत्वा द्वावेकसमासेन समस्येत् स पुरुषः ।

5 6 पञ्चविभागेन बृहती तस्य दशमविभागेन पादमात्री भवति ।

5 7 पुरुषं वा पञ्चमेनोभयतोऽपच्छिद्य पञ्चविभागान् समस्य तृतीयं निर्हृत्य तस्मिन् पुरुषप्रमाणेऽवदध्यादित्यपरम् ।

5 8 पञ्चदशविभागोऽष्टाङ्गुलम् ।

5 9 पञ्चारत्निर्दशवितस्तिर्विंशतिशताङ्गुलः पुरुष इत्येतस्माद्द्वादशाङ्गुल पदमिति च ।

5 10 पुरुषं वा सप्तमेनोभयतोऽपच्छिद्य सप्तभागान् समस्य ससप्तमभागमङ्गुल निर्हृत्य पुरुषप्रमाणेऽवदध्यादित्यपरम् ।

5 11 नारत्निवितस्तीनां समासो विद्यते सङ्ख्यायोगादिति श्रुतेः ।

6

6 1 यथाग्नि वेदिष्टकाप्रमाणं वर्धत इत्येतद्वक्ष्यामः ।

6 2 या करणी चतुर्दशप्रक्रमान्सङ्क्षिपति त्रिंश प्रक्रमसप्तमभागान् स एकशतविधे प्रक्रमः ।

6 3 द्वितीये वा सप्तसु प्रक्रमेषु प्रक्रममवधाय तस्य सप्तमभागेन प्रक्रमार्थः ।

6 4 प्रक्रमेण वा सप्तमभागेन प्रक्रमार्थाः ।

6 5 एवमैकेशतविधात् ।

6 6 नान्तःपात्यगार्हपत्ययोर्वृद्धिर्भवति तावदेव योनिर्भवति न वै जातं गर्भं योनिरनुवर्धता इति श्रुतेर्वृद्धेरत्यन्तं प्रतिषेधः ।

6 7 यावत्प्रमाणानि समचतुरश्राण्येकीकर्तुं चिकीर्षेदेकोनानि तानि भवन्ति तिर्यग्द्विगुणान्येकत एकाधिकानि त्र्यस्रिर्भवति तस्येषुस्तत्करोति ।

6 8 यथायूपं वेदिवर्धनमित्येतद्वक्ष्यामः ।

6 9 या रज्जुरेकादशोपरवान् सङ्क्षिपति दश च रथाक्षांस्तस्या यश्चतुर्विंशो भागः स प्रक्रमः ।

6 10 तेन वेदिं निर्माय द्वादशाङ्गुलं पुरस्तादपच्छिद्य तद्यूपावत्याच्छङ्कोः पुरस्तात्प्राञ्चमवधाय तस्मिन् यूपान्मिनोति ।

6 11 पार्श्वयोर्वाऽर्धमन्तर्वेदीति श्रुतेरर्धकानीति ।

6 12 एके प्रथमोत्तमौ प्रकृतिवत् ।

6 13 सैषा शिखण्डिनी वेदिः ।

Indological Truths

MĀNAVA-ŚULBASŪTRA

1

1 1 अथातः शुल्बं व्याख्यास्यामः । (10 1 1)

1 2 रज्जुं पाशवर्तिं समां निरायता समा निरायतां पृष्ठ्या यथार्थमुपकल्पयेत् ।

1 3 अन्तरेण चित्रास्वाती श्रवणप्रतिश्रवणौ कृत्तिकाप्रतिकृत्तिके तिष्योपुनर्वसू च प्राग्देशोऽयं युगमात्रोदितयोः पाशाश्च ।

1 4 दार्शिक्याः शयाः षट्तानि सप्त सप्तदशैव तु ।
एक द्वे पञ्च तैर्मीत्वा समरैः परिलेखयेत् ॥

1 5 अंशाच्छ्रोणौ रज्ज्वन्तं प्रतिष्ठाप्य प्राचीमनुलिखेदंसे प्रतिष्ठाप्य प्रतीची समरे रज्ज्वन्तं प्रतिष्ठाप्य श्रोणेरध्यंसादनुलिखेत् ।

1 6 एवनुत्तरतः पुरस्तात्पश्चाच्च ।

1 7 अरत्निश्चतुरश्रस्तु पूर्वस्याग्नेश्चरो भवेत् ।
रथचक्राकृतिः पश्चाच्चन्द्रार्धेन तु दक्षिणे ॥

1 8a मध्यात् कोटिप्रमाणेन मण्डल परिलेखयेत् ।
अतिरिक्तत्रिभागेन सर्वं तु सहमण्डलम् ॥

1 8b चतुरश्रेऽक्ष्णया रज्जुमध्यतः सन्निपातयेत् ।
परिलेख्य तदर्धेनार्धमण्डलमेव तत् ॥

1 9 गार्हपत्याहवनीयावन्तरा रज्जुं निमायापरस्मिंस्तृतीये लक्षणम् । मध्यात् तुरीयमुत्सृज्य लक्षणं पाशान्तौ समाहृत्य दक्षिणतो दक्षिणाग्नेरलक्षणम् ।

1 10 एतदेव विपर्यस्योत्तरत उत्करस्य लक्षणम् ।

1 11 यावत्प्रमाणा रज्जुः स्यात्तावदेवागमो भवेत् ।
आगमार्धे भवेच्छङ्कुः शङ्कोरर्धे निराञ्चनम् ॥

1 12 समन्तचतुरश्राणि विधिरेषः प्रकीर्तितः ।

Indological Truths

2

2 1 अष्टाशीतिः शतमिषा तिर्यगक्षश्चतुःशतम् । (10 1 2)
षडशीतिर्युगं चास्य रथश्चारक्य उच्च्यते ॥

2 2 ईषायां लक्षणं मित्वा षट्सु नवसु च लक्षणे ।
त्रिचत्वारिंशके पाशोऽङ्गुलाना नियोगतः ॥

2 3 एषा वेदिः समाख्याता चारक्या रथसम्मिता ।
ऐन्द्राग्नस्य पशोरेषा पशुष्वन्येषु षट्शया ॥

2 4 प्राच्यर्धः षडरत्निः स्यादर्धारत्नेर्निराञ्छनम् ।
अर्धे श्रोणी ततोऽर्धेऽसावध्यर्ध इति पाशुकी ॥

2 5a पशादर्धशये श्रोणी द्वयोः पृष्ठ्यापरा द्वयोः ।
प्राच्यर्धस्तु ततोऽध्यर्धे ततोऽध्यर्धे निरञ्छनम् ॥

2 5b अर्धेऽशोऽध्यर्ध एवान्यस्ततोऽर्ध्यर्धेऽस उत्तरतः ।
अरत्नौ तु ततः पाशो वेदि मारुती वारूणी ॥

2 6 सर्वा दशशया रज्जुर्मध्ये चास्या निराञ्छनम् ।
प्राच्यर्धं पञ्चमे कुर्याद्दिक्कुष्ठा पैतृकी स्मृता ॥

2 7 सर्वा सप्तशया रज्जुर्मध्ये चास्या निराञ्छनम् ।
प्राच्यर्धं पञ्चमे कुर्याद्दिक्कुष्ठा पैतृकी स्मृता ॥

3

3 1 प्राग्वंशं दशक कुर्यात्पत्नीशाला चतुःशयाम् ।(10 1 3)
प्राग्वंशात्त्रिषु वेद्यन्तो वेद्यन्तात् प्रक्रमे सदः ॥

3 2 नवक तु सदो विद्याच्चत्वारः सदसोऽन्तरम् ।
चत्वारस्त्रिका हविर्धानमर्धादशास्तदन्तरम् ॥

3 3 पदं यूपावटे मित्वा शेषमौत्तरवेदिकम् ।
आग्नीध्रं षडरत्न्येव षट्त्रिंशत्प्रक्रमा रज्जुः ॥

3 4 लक्षिका द्वादश त्रिका । वेदिसदोहविर्धानानि मिनोत्येवानुपूर्वशः पञ्चदशकमेकविंशकं त्रिकमपरम् ।
परतोऽपरस्त्रिको द्वादशसु च पाशद उच्यते । सोमे रज्जु निमानमुत्तमम् ।

Indological Truths

3 5 त्रिपदा पार्श्वमानी स्यात्तिर्यङ्मानी पदं भवेत् ।
तस्याक्ष्णया तु या रज्जुः कुर्याद्दशपदा तया ॥

3 6 पाशादर्धचतुर्दशे नवके तु ततः पुनः ।
अर्धचतुर्दशः पाशः सदसश्छेदनमुत्तमम् ॥

3 7 निमाय रज्जुं दशश्री रथाक्षैरेकादशभिश्चोपरबुध्नमात्रैस्तस्याश्चतुर्विंशतिभागधेयमेकादशिनी प्रतिवेदिमाहः ।

3 8a शिखण्डिनी चेत्कर्तव्या वेद्यन्ताद्द्व्यर्धमुद्धरेत् ।
अष्टाङ्गुलं तदर्धं स्यादेव्य वेदि प्रसिद्धये ॥

3 8b तं प्राञ्चं तु समीक्षेत तांस्तु विद्याच्छिखण्डिनीम् ॥

3 9 पञ्चकं सप्तं चैव एकमेकं ततः पुनः ।
एषा वेदिः समाख्याता कौकिल्यास्त्वथा चारके ॥

4

4 1 जन्मना रोगहीनो वा यजमानो भवेद्यदि ।(10 1 4)
कथं तत्र प्रमाणानि प्रयोक्तव्यानि कर्तृभिः ॥

4 2 तुण्डं पुष्करनालस्य षङ्गुणं परिवेष्टितम् ।
त्रिहायण्या वत्सतर्या वालेन सममिष्यते ॥

4 3 त्रयस्त्रिहायणीवालाः सर्षपार्धं विधीयते ।
द्विगुणं सर्षपं प्राहुर्यवः सर्षपारम् ॥

4 4a अङ्गुलस्य प्रमाणं तु षड्यवाः पार्श्वसहिताः ।
दशङ्गुलस्तु प्रादेशो वितस्तिर्द्वादशाङ्गुलः ॥

4 4b द्विवितस्तिररत्निः स्याद्व्यायामस्तु चतुःशयः ।

4 5 विंशतिशताङ्गुलतः पुरुषः स्वैः स्वैरङ्गुलिपर्वभिः ।
अथ चेत्प्रपदोत्थानः पञ्चविंशशतो भवेत् ॥

4 6 त्रियवं कृष्णलं विद्यात् मानं विद्यात् त्रिकृष्णलम् ।
अनेन कृष्णलप्रमाणेन निष्कमाहुश्चतुर्गुणम् ॥

Indological Truths

4 7 पुरुषस्य तृतीयपञ्चमौ भागौ तत्करणं पुनश्चितेः ।
तस्यार्धमथापर भवेत्त्रिचितिकमग्निचितिश्चेत् ॥

4 8 अष्टावष्टौ सम्मिता चितिरष्टैकादशिका च मध्यमा ।
व्यत्यासवतीरुपन्यासेदष्टौ द्वादश चोत्तमा चितिः ॥

5

5 1 अथात उत्तरेष्टक व्याख्यास्यामः ।(10 2 1)

5 2 ऊर्ध्वबाहुना यजमानेन वेणुं विमिमीते ।

5 3 तत्समोऽन्यतरः सारत्निर्द्वितीयस्तस्य पुरुषे लक्षणमरत्नि वितस्तयोश्चभयोरर्धपुरुषे ।

5 4 शिरसि परिश्रिते यूपायावेशिष्य शेषमनुरज्जु पुरुषौ सन्धाय पश्चाड्ग्या शङ्कुं विनिहन्ति तयोः सन्धावर्धयोश्च ।

5 5 यावभितो मध्यमं शङ्कुं तयोर्वेणू निधाय दक्षिणतः पुरुषसन्निपाते तोदं करोति ।

5 6 मध्यमे शङ्कौ वेणुं निधायाध्यधि तोदं हृत्वा दक्षिणतः पुरुषे शङ्कुं निहन्ति ।

5 7 पूर्वे शङ्कौ वेणुं निधाय द्वितीयं दक्षिणतः पुरस्तात्पुरुषसन्निपाते शङ्कु निहन्त्यर्धे चैवं पश्चात् ।

5 8 एतेनोत्तरार्धो व्याख्यातः ।

5 9 दक्षिणस्य वर्गस्य यावभितो मध्यम शङ्कुं तयोर्वेणू निधाय दक्षिणतः पुरुषसन्निपाते तोदं करोति ।

5 10 मध्यमे शङ्कौ वेणुं निधायाध्यपि तोदं कृत्वा दक्षिणतः सारत्नौ सङ्कुं निहन्ति ।

5 11 यः सारत्निस्त मध्यमस्य पूर्वे निधाय द्वितीय दक्षिणतः पुरस्तात्सारत्निमर्धपुरुषेण सन्निपात्य शङ्कुं निहन्त्येवं पश्चात् ।

5 12 एतेनैवोत्तरपक्षो व्याख्यातः ।

5 13 पुच्छम् । सवितस्तिररत्निस्थाने ।

5 14 पूर्वस्य पुरस्तादर्धपुरुषेण पश्चाड्ग्या शिरो विमिमीते ।

6

6 1 व्यायामस्याष्टममेकतस्तुरीयमेकत उभयतस्तुरीयं चते गार्हपत्यचितेः हरणे । (10 2 2)

6 2 पुरुषस्य दशमेन भागेन प्रथमं चतुरश्रं करणं कारयेद्दशममेकतोऽर्धमेकतस्तद्द्वितीयं दशममेकतोऽध्यर्धमेकतस्तत्तृतीयमुभयतस्तुरीयं तच्चतुर्थम् ।

Indological Truths

6 3 तासामुत्सेधस्त्रिंशत्पञ्चमभागेनान्यत्र नाकसद्भ्यश्च चूडाभ्य ऋतव्याभ्योऽथ मध्यमायां पञ्चमषष्ठीभ्यश्च वैश्वदेवीभ्यस्ता अर्धोत्सेधाः ।

6 4 पुरीषमन्तर्धायोत्तरामुपदध्याद्व्रणसंसर्गायाविच्छेदाय ।

6 5 गर्तेषूपदध्याद्यदन्यदिष्टकाभ्यः ।

6 6 तत्र श्लेको भवति ।

उखायाः पशुशीर्षानां कूर्मस्योलूखलस्य च ।
स्रुचोः कुम्भेष्टकाना च चरोश्चैवावटाद्भनेत् ॥

6 7 प्रतिदिशमुपदध्यादात्मनि मध्ये प्राचीः शिरसि पुच्छे पक्षयोश्चात्मन्यप्ययेषु समं विभज्योत्तरामुत्तरा-मप्ययसंहितां पूर्वापरदक्षिणोत्तरा विषयवचनादन्यच्चतस्रः पुरस्तात्पश्चर्तव्याभ्यः पश्चाच्चोत्तरपूर्वे चार्धे गार्हपत्यस्य । शेषं चतुरश्राभिः ।

6 8 एता एव दक्षिणोत्तरा द्वितीयस्यां । शेषं चतुरश्राभिः ।

6 9 यथा प्रथमैवं तृतीया पञ्चमी वा यथा द्वितीयैवं चतुर्थे । तेन धर्मेण वत्यासं चिनुयात् ।

6 10 अथेतरानाग्नीध्रीयादीन् नवनव पदानि करोत्येकैक मध्येऽस्मानमाग्नीध्रीये । चत्वारि चत्वरि तुरीयाणि प्रतिदिशं होत्रिये । चतस्रोऽर्धाः कुष्ठासु ब्राह्मणाछंस्य । इतरेषा द्वे द्वे अध्यर्धे मध्ये प्राचीः । षडेव मार्जालीये पशुस्रपणे च ।

6 11 विंशतिमध्यर्धाः प्राचीरंसयोर्दद्याच्छ्रोण्योः पुच्छे च विंशतिं द्वादश द्वादश पुरस्तात्पक्षयोः प्राचीः पञ्चाच्च पञ्च पञ्च चोदीचीरभितः शिरसि । शेष चतुरश्राभिः ।

6 12 विंशतिं श्रोण्यंसपक्षेषूदीचीर्दक्षिणतस्तथोत्तरतो द्वितीयस्यामेकादशैकादशाभितः पुच्छे पञ्च पञ्च प्राचीरभितः शिरसि । शेषं चतुरश्राभिः ।

6 13 यथा प्रथमैव तृतीया पञ्चमी च यथा द्वितीयैव चतुर्थ्येतेन धर्मेण व्यत्यास चिनुयात् ।

6 14 त्रिरुपसत्सु द्वे पूर्वस्यां तिस्रो मध्यमाया षट्सु यथानुपूर्वेण द्वादशसु व्यत्यासं चितिपुरीषे करोति ।

6 15 एतेन धर्मेण संवत्सरात्समं विभज्य जानुदघ्नेऽस्य द्विगुणं त्रिगुणामुत्तरेषां चैकामुत्तरामुद्धत्याभ्यायनं वर्धायातिरिक्ता उपदध्यात् ।

6 16 मन्त्राद्यभिमर्शनान्तं तत्पुरुषस्य लक्षणम् ।

7

7 1 दर्भस्तम्बं पुष्करपर्णं रुक्मपुरुषौ हिरण्येष्टका शर्करां स्वयमतृण्णां दूर्वेष्टका नैवारमिति मध्यं (आ पञ्चमाश्रं स्वयमातृण्णाया अभितस्ता मध्यम् । तस्मिन्कुम्भेष्टका या मध्ये दक्षिणोत्तरे च

Indological Truths

स्रुचावनूपमध्येषु शेषः। पश्चात्स्वयमातृण्णायाः कुलायिनी द्वियजुश्च वंशयः पार्श्वसहिते द्वियजुरुत्तरे पुरस्ताद्रेतःसिचौ द्वे । दक्षिणे तस्मिन्वंशे द्वितीयामृतव्यां च पुरस्ताच्चतुर्थे लोके रेतःसिच विश्वज्योतिष मण्डलामृतव्यां घर्मेष्टकामषाढा कूर्मं वृषभमिति प्राञ्चमुत्तरे वंशे दक्षिणतः पुरस्तात्स्वयमातृण्णायाः पञ्चमुलूखलमुसलमुत्तरपूर्वे चोखा मध्ये शिरसा शिरोभिः संहितामुपदधाति। (10 2 3)

7 2 तस्याः पश्चात्पुरुषशिरसः पुरुषचितिमुपदधाति षट्त्रिंशत प्रतीची त्रिवर्गेण श्रोण्याम्।

7 3 तत्र श्लोको भवति।

तिस्रो ग्रीवाः षडंशयोर्द्वे द्वे बाह्वोर्नवात्मनि।
जङ्घयोरु पञ्च पश्चादस्मानामेकैक पाणिपादयोः॥

7.4 अष्टवथापस्याः समं विभज्य वंशेषु नवमेनवमे प्राणभृतः पश्चाद्दक्षिणतः स्वयमातृण्णाया द्वितीये पञ्चममनूपेषु संयतो नवमेऽतिमात्रा यथा प्राणभृतः पुरस्ताद्दक्षिणे वंशे प्रथमं पश्चादुत्तरे दक्षिणतः पश्चादुत्तरतः पूर्वा उत्तरतः पश्चाद्दक्षिणतः उत्तरतः स्वयमातृण्णाया द्वितीये पञ्चमम्। वैश्वदेव्यश्चानूपेषु प्रतिदिशमुत्तरपूर्वेषु वंशेष्वाद्या। दक्षिणोत्तरे च सयान्यावप्यये तयोर्वंशयोराद्यात् पुरस्ताद्वाथर्वशिरः।

7 5 समं विभज्य वंशेषु शिरः पक्षपुच्छानि प्रथमेषु वंशेषु लोकान्विजानीयात्।

7 6 शिरसि प्रथमे वशे उत्तरामुत्तरामितरेषा पक्षपुच्छानां चतुर्थे पक्षयोः प्राचीः पुच्चे चोदीचीर्लोकेष्टका उपदध्याच्छेषाः पश्चात्स्वयमातृण्णाया एकैका पूर्वं सहिताम्। दक्षिणे वंसे वैश्वदेव्याद्य उत्तरे च पुरीषाद्याः।

7 7 गायत्र मध्ये शिरसि रथान्तरं बृहद्यज्ञायमिति यथाम्नातम्।

8

8 1 द्वितीयां पुरस्तात्स्वयमातृण्णायाः प्रथमद्वितीयतृतीयेष्वर्तव्या वायव्या अपस्या इति यथासङ्ख्यम्। तिस्रस्तिस्रो दक्षिणेषु वंशेषु दक्षिणोत्तरा द्वे द्वे उत्तरस्योत्तरयोर्नवमेऽभितः शेषा यथापस्याः। (10 2 4)

8 2 तृतीयां दश द्वादश नवमेऽभितो। अष्टमे सप्त पुरस्तात्पश्चाच्च समीचीरभितः स्वयमातृण्णाया अर्धोत्सेधा अष्टौ नानामन्त्रा उत्तमाया वा।

8 3 चतुर्थ्यामेकैक नवमेनवमेऽभितः पुरस्तादुत्तरस्य वशस्य मध्ये प्रथमा व्यत्यासमितरा।एवेव स्पृतः पुरस्ताद्दक्षिणस्य वंशस्य मध्ये प्रथमां व्यत्यासमितराः। षट्सप्ताष्टमेषु दक्षिणतो युग्मायुग्मा उत्तरतस्त्रिवर्गान्कुर्यात्सप्तदश दक्षिणतः पञ्चदशोत्तरतः।

Indological Truths

8 4 पञ्चम्यामेकैका प्राणभृदाधिषु शेष छन्दसा विराजश्च यथातिमात्राः षट्सप्ताष्टमेस्वभितो यथासङ्ख्यम् ।

8 5 अर्धेष्टकाभिः पूरयित्वा दक्षिणतः प्राचीः स्तोमभागाः पश्चिमाश्च युग्मा उत्तरतस्त्रिवर्गान्कुर्यादेकत्रिंशतम् । पश्चात्प्रत्यञ्चं त्रिवर्गेण नाकसदं च पश्चात्पुरीषवत्या यवादिना सनाम्नीरुपशीवरीर्घृतप्लुता इति यथासङ्ख्यम् । तुरीयाणि मध्ये यथा प्राणभृतोऽतिमात्रा मध्यमां स्वयमातृण्णासंहितामुत्तरंस्तु विकर्णिम् ।

8 6 इति सुपर्णस्य ।

9

9 1 यावती शोषपाकाभ्यामिष्टका ह्रसते कृता । (10 2 5)
तावत्समधिक कार्यं करण सममिच्छत ॥

9 2 सदा च त्रिंशकं भागमिष्टका ह्रसते कृता ।
तावत् समधिक कार्यं करणं सममिच्छत ॥

9 3 एकैक शतमध्यर्धं तोदूतं षडभिरङ्गुलैः ।
इष्टकानां परिमाणं वैकृतं यदतोऽन्यथा ॥

9 4 नवाङ्गुलसहस्राणि द्वे शते षोडशोत्तरे ।
अङ्गुलानां परिमाणं व्यायामस्य तु निर्दिशेत् ॥

9 5 इतरेषा तु धिष्ण्याना सर्वेषामेव निश्चयः ।
एकैकस्य सहस्रं स्याच्छते षण्णवतिः परा ॥

9 6 एकादश सहस्राणि अङ्गुलानां शतानि षट् ।
शत चैव सहस्राणां क्षेत्रमर्धाष्टमान्तरे ॥

9 7 प्राकृतं वैकृत वापि क्षेत्रमर्धाष्टमान्तरे ।
पञ्चविंशं शिरः कृत्वा ततः क्षेत्रे समावपेत् ॥

9 8 शतान्यष्टौ पदोनानि पदानामिह कीर्त्यन्ते ।
साङ्गस्य सशिरस्कस्य क्षेत्रं क्षेत्रविदो विदुः ॥

9 9 आत्मा चतुःशतः कार्यः पक्षौ त्रिंशच्छतौ स्मृतौ ।
दश पुच्छे शतं चैव शिरः स्यात् पञ्चविंशकम् ॥

Indological Truths

9 10 एकत्रिंशत्त्रयस्त्रिंशैर्वर्गैः पञ्चाशकैरपि ।
असम्भवत्सु वर्गेषु द्विधा भिद्येत इष्टका ॥

9 11 इष्टकाह्रासवृद्धिभ्यां दृढासु शतकेषु च ।
मतिमानिष्टका भागैर्मन्त्रात्सम्नाशयेदिति ॥

9 12 चतुरश्रे पृष्ठ्यै वापि पक्षपुच्छशिरेष्टकाः ।
दित्तोऽपधान लोकाच्च तथा लोकस्तु लुप्यते ॥

9 13 अध्यात्मनि ह विज्ञेयमुपधान विजानता ।
रथन्तरबृहल्लोकैरन्य गायत्रयाज्ञियैः ॥

9 14 यजुष्मतीनां सङ्ख्या तु सर्वासा चैव निश्चिता ।
एकैकस्यां चितौ वापि तां मे निगदतः शृणु ॥

9 15a षडशीतिः शत त्वाद्या द्वितीया दश सप्ततिः ।
त्रयोदश तृतीया स्याच्छतं चाहुर्मनीषिणः ॥

9 15b चतुर्थी शतमेका स्यात्तिस्रश्चैवेष्टकाः स्मृताः ।
शतानि त्रीणि पञ्चाशत्षट्चैव चितिरुत्तमा ॥

9 16 एताः सर्वा यजुष्मत्यो याभिरग्निः प्रसूर्यते ।
शेषं लोकम्पृणाभिस्तु चितीनामभिपूरयेत् ॥

9 17 एताः सर्वा समाम्नाताः यजुर्यावत्प्रवर्तते ।
तदेतद्धि सहस्रं स्याच्छर्कराभिः सहोच्यते ॥

9 18 एता उपहिताः सम्यग्धेनवस्तु प्रजायन्ते ।
अमुष्मिन्यजमानाय कामान्दुह्यति सर्वशः ॥

9 19 षष्टिं प्रजापतिं वेद यो हि संवत्सरः स्मृतः ।
गच्छति ब्रह्मणो लोक नोकं ब्रध्नस्य विष्टपम् ॥

10

10 1a वैष्णवे या प्रमेयाय शुल्बविद्भिश्च सर्वशः । (10 3 1)
सङ्ख्यातृभ्यः प्रवक्तृभ्यो नमो भरन्तो यो मसे ॥

Indological Truths

10 1b इदं भूम्या भजामहे या न मानकृतामिव ।
यज्ञियं मानमुत्तम वर्धमान स्वे दमे ॥

10 2 स्पष्टा भूमिर्जुः शङ्कुर्मौञ्जं शुल्बमबन्धुरम् ।
चित्रादौ नाकृतिः कार्या तिथ्यृक्षं वरुणशुभम् ॥

10 3 सर्वाः प्रागायता वेद्यः करणं यस्कदेहिकम् ।
अर्धेनार्वसम सर्वमुच्छेदो जानु पञ्चकम् ॥

10 4 मध्यमेऽर्धमृतव्यानां नाकसत्पञ्चचूडयोः ।
करणाद्यर्थमुद्दिश्य क्षेत्रमर्धाष्टमान्तरः ॥

10 5 अनःसिद्धं हविर्धानं पात्रसिद्धाः खराः खराः ।
चात्वालः पशुभिः सिद्धो हविर्भिः साग्निकाः खराः ॥

10 6 मण्डलार्धं चतुःस्रक्ति रत्निनां विहिताः खराः ।
अरत्निर्घन एतेषां भूयस्त्वे भूयसीबिधौ ॥

10 7 पूर्वश्चतुर्विंशतिभागे लेख्यश्चतुर्वंशैरालिखितस्तु पश्चिमः स्याद्दक्षिणेऽष्टद्विगुणेन लेख्यस्त्रिंशद्भिरायम्य हरेत्तुरायम् ।

10 8 उदक्प्रक्रम्य चात्वाल शामित्र प्रक्रमे ततः ।
भूयस्तत्पशुभूयस्त्वे वृद्धिरुत्तरतो भवेत् ॥

10 9 आयामबाहु निक्षिप्य विस्तरस्तु तथा पृथक् ।
सोऽध्यर्धं गुणयेद्राशिं स सर्वगुणितो घनः ॥

10 10 आयाममायामगुणं विस्तारं विस्तरेण तु ।
समस्य वर्गमूलं यत्तत्कर्णं तद्विदो विदुः ॥

10 11 श्रवणाभिजितोबहुलातिष्ययोर्वा चित्रास्वात्योरन्तरेऽप्स्वग्निना वा ।

10 12 नक्त प्राचीभास्करश्रायमाहुः । शङ्कुलिप्ते मण्डले प्राक्पराक्चेति ।

11

11 1 जन्मना रोगहीनो वा यजमानो भवेद्यदि । (10 3 2)
कथं तत्र प्रमाणानि प्रयोक्तव्यानि कर्तृभिः ॥

Indological Truths

11 2 यद्युरुतन्तुः केशोवास्तृतः सर्षपो यवश्चैव षङ्गुणितः षङ्गुणितो भवति नरस्याङ्गुलं माने तद्द्वादशक प्रादेशमित्याहुः ।

11 3 तद्द्वयं स्मृतोऽरत्निः प्रक्रमोऽरत्निसमः स द्विःप्रादेशो भवेच्चितिषु ।

11 4 अध्यर्धाङ्गुलहीनाश्चत्वारः प्रक्रमा भवेन्नियताः ।

11 5 तत्रैकादश यूपाश्चत्वारश्चतुरुत्तराः सत्त्रेसत्त्रे ।

11 6 एकस्या वेद्यामग्निद्वयमिष्टकारिक्त भवति । पृथगतो वेदिः चेत्पृथगगनिः क्लृप्तः ।

11 7 विंशत्यङ्गुलः शतं नियतः पञ्चारत्निर्नरो दशपदो वा । हीनातिरिक्तयुक्त्या देहेदेहे प्रमाणं तु ।

11 8 षडशीतिर्युगमुक्त साष्टादश उच्यते त्वक्षस्तन्त्रसमसमस्तं द्व्युज रथमाषा व्यवास्यन्ति ।

11 9 मण्डलमथ चतुरश्रं मण्डलं च यः कुर्जात्तस्येम करणविधिं तद्विदामुदाहृतं शृणुत ।

11 10 मण्डलविष्कम्भार्ध समस्त्रिभुजादवलम्बकश्चतुःस्रक्तिः प्रागायतात्त्रिभागात्कर्णात् स मण्डलं भवति ।

11 11 पुरुषः पुरुषं कुर्यात्तस्याक्ष्णया द्विपुरुषं भवेच्चतुरस्तस्याप्यक्ष्णया द्वाभ्यां वा स्याश्चतुःपुरुषम् ।

11 12 द्विपुरुषः करणी श्रोणी बाहुस्तु द्विगुणो भवेत्त्रिङ्कुष्ठवत्त्र्यवलम्बकस्ततो यश्चतुरश्रे द्वाष्टमाः पुरुषाः ।

11 13 विष्कम्भः पञ्चभागश्च विष्कम्भस्त्रिगुणश्च यः ।
स मण्डलपरिक्षेपो न वालमतिरिच्यते ॥

11 14 दशधा छिद्या विष्कम्भं त्रिभागानुद्धरेत्ततः ।
तेन यच्चतुरश्र स्यान्मण्डले तदपप्रथिः ॥

11 15 चतुरश्रं नवधा कुर्याद्धनुःकोट्यस्त्रिधात्रिधा ।
उत्सेधात्पञ्चमं लुम्पेत्पुरीषेणेह तावत्समम् ॥

11 16 चतुररत्निर्वा नरः सिकताकरणे त्वर्धं भुजः प्रदिश्यते ।

11 17 करणानि ततोऽस्याः कारयेत्त्रिचतुःपञ्चत्रिरभिपर्यस्य यच्छुभं चयनेषु विधिः पुरातनैर्ऋषिभिर्योऽभिहितश्च नित्यश ।

11 18 परिलेखनमानसञ्चयैर्व्यत्यास्यैः परिमाणसम्पदा वेद्यः सर्वाः प्रमाणैरायामेन च विस्तरेण च मिमीयात् ।

11 19 चतुरश्रसम्पदाद्व्यायामसमापनाः स्मृता पञ्चाङ्ग्याथ वा पुरातनैर्याः पूर्वैर्ऋषिभिः प्रदर्शिताः ।

11 20a यश्चैष विधिर्मयाकृतस्तत्रैषा मिथुनात्समम् ।
पञ्चाङ्गी तावती रज्जुर्यया सर्वं मिमीमहे ॥

Indological Truths

11 20b ऋते कङ्कालजश्यनां स्तेषा वक्ष्यामि लक्षणम् ॥

11 21 इयं मिता या समयार्धलक्षणा ततश्चतुर्थे भवेन्निराञ्छनं ततोऽर्धशिष्टा विस्तारसमा चयस्य । यत्ततश्चतुःकुष्ठमिहानया चरेत् ।

11 22 प्राचीतथायामसमा निदध्यात्पशौ निखन्यादथ मध्य च ।

11 23 उन्मुच्य पश्चादथ मध्यमे तत्प्राग्दक्षिणायम्य निराञ्छनेन विस्तारतोऽर्धे निखनेत शङ्कुम् । प्रत्यक्तथोत्तरमध्यमे च । वासुवेदिषु ।

11 24 अथ मानमेतच्छ्रोण्यां तु पाशोद्धरणं क्रियेत ।

11 25 अंसश्रोण्योर्लिखेत् दिक्षु लेखाः । शङ्कू निहन्यात्समरेषु तेषु । तेभ्यः समन्तात्परिलेखयेत् ।

11 26 यद्यैष्टिका नोभौ लिखेत शिष्टौ ।

11 27 पूर्वे त्रिभागे त्वपरे च सिद्धोपस्थितावुत्करदक्षिणाग्नी ।

11 28 अथान्यदस्य परिलेखनं तु मध्ये भवेद्दिक्षु नवाङ्गुलेनेति ।

12

12 1 प्रमाणार्धं तु षष्टयूनं विशेष इति सञ्ज्ञितम् । (10 3 3)
विशेषश्च प्रमाणं च प्रमाणस्याक्ष्णया भवेत् ॥

12 2 प्रमाणार्धमन्यत्स्यात् पाशषष्ठे सचतुर्विंशे लक्षणं करोति तन्निराञ्छनमक्ष्णया तिर्यङ्मानी शेषः पाशादर्धशये श्रोणी द्व . ।

12 3 चाग्नीध्रमिहोपदिश्यते ।

12 4 अग्नेर्यदक्ष्णयामानं तस्य चैव तदक्ष्णया ।
तदाश्वमेधिक विद्यादेकविंशद्विधौऽथवा ॥

12 5 पुरुषस्तिर्यग्भवेद्यदनुदशधा यो मितः ।
तस्य कर्णेन यत्क्षेत्र विद्यादेकादश तु तत् ॥

12 6 उभौ बाहू नशक्ष्णां तु नरस्तिर्यक्तदक्ष्णया ।
एकोच्चतानैकशताद्बाहुवृद्धया विवर्धयेत् ॥

Indological Truths

13

13 1 अवलम्बककुष्ठे तु यो भवेत्षोडशाङ्गुले । (10 3 4)
सौत्रामण्या भवेदेष प्रक्रमो मानकर्मणि ॥

13 2 प्रक्रमस्य तृतीयेन सौमिकी सार्पराज्ञिकी ।
सन्तृतीयैस्त्रिभिश्चान्यैः सिद्धमौत्तरवेदिकाम् ॥

13 3 चतुर्दशाङ्गुलो वा स्यात्प्रक्रमस्तेन सौमिकी ।
शतैर्द्वादशभिर्वापि मिनुयात्पशुकामिव ॥

13 4 सचतुर्थे वनं षड्भिर्नवभिर्वाथ सप्तभिः ।
नवभिर्वापरं चक्र करणार्धे न लेखयेत् ॥

13 5 चतुर्षु निवपेदेषां सावित्रादिषु यो विधिः ।
अरुणे जानुदघ्ने निखन्यादभिस्तु पूरयेत् ॥

13 6 चतुरश्रमथापि मण्डल द्विविध गार्हपत्यलक्षणं व्यायाममितं चतुर्भुज पुरुषार्धेन तु मण्डल परिलिखेत् ।

13 7 व्यायामतृतीयमायान्तं चतुरश्रं सप्तमभागविस्तृतं प्रागाचितमुत्तराचितं व्यत्यासे तदथैकविंशकम् ।

13 8 पुरुषस्य तृतीयमायान्तं चतुरश्र षड्भागविस्तृतम् । प्रथिकश्च तदायतो भवेन्मध्ये तेन समायतो भवेन्मध्ये तेन समास्तिके शेषौ । कोणौ प्रथिकमितौ समौ तद्विस्तारकृतौ विशाखः ।

13 9 षड्भागकृतायामो भवेद्द्व्यर्धे तु त्रिकोणसस्थिते ।

13 10 चतुरश्रविपाणकः प्रथिकोऽर्धं प्रथिकश्च यो मितः ।

13 11 करणानि भवन्ति मण्डले चत्वारि प्रमितानि भागशः ।

13 12 मध्येऽस्य चतस्र इष्टकाः तत्पूर्वापरयोर्द्वयोर्द्वयम् । प्रथिकोऽर्ध विषाणिकद्वयं पुनरेव पुनरैति मण्डलमर्धप्रथिकद्वये समम सम्पूर्णम् । तदथैकविंशकम् ।

13 13 व्यत्यासमुदङ्मुखेन सह व्यत्यास्येद्वेत्युत्तरोत्तरम् ।

13 14 अध्यर्धं पद्य च पद्यार्धपद्यपादवत्पद्यार्धोत्सेधिमित्याहुर्गायत्रे करणानि च ।

13 15 चतुर्गुणा द्विपुरुषां रज्जुं कृत्वा समाहिताम् ।
सम्भागज्ञातृतोदान्तां पञ्चाङ्गी तद्विदो विदुः ॥

13 16 मध्यमात्पाशयोस्तोदो गायत्रमानमुच्यते । सारत्नावर्धपुरुषे । चतुरश्रस्तया मितः । पक्षपुच्छान्तयोर्वृद्ध्या गायत्रेणेतरेषुभिः ।

13 17 इष्टका शोषपाकाभ्यां त्रिंशन्मानात्तु हीयते ।

Indological Truths

13 18 ततः क्षेत्रं त्रिचतुर्भाग निरुह्यादापयेच्छिवम् ।

13 19 अंश उत्तरेऽंशे च प्राच्योऽध्यर्धास्तु विंशतिर्दश पुच्छे द्विर्द्वादशकौ पक्षयोरभितः पुच्छे तु पञ्च देयाः पञ्च प्राचीः पञ्चदश दद्याच्छिरसि । चतुरशीती पक्षयोः पञ्चाशतं त्रिंशतमात्मनि पद्या भवन्ति शतमेकोन पुच्छेऽसश्रोण्योर्विंशतिर्विंशतिः पुच्छे पक्षयर्दशदशाहुः ।

13 20 अध्यर्धा दश शिरसि प्राच्युदीच्यो भवन्ति ।

13 21 पूर्वोपहिता प्रथमा पदयुजः सर्वा । द्वितीयावाग्युजोऽश्विनी ।

13 22 व्यत्यासं चिनुयादेवं जानुनास्य वर्तमसु ।

13 23 त्रिपदा अल्पेत्रा एकचितिकाश्चतुः करणयुक्ताः धिक्ष्ण्या भवन्ति साग्निचित्यमन्त्राः सातिरिक्ताश्च ।

13 24 अध्यर्धास्तु चतस्रो द्वे मध्ये नकुलश्चतुर्भागः ।

13 25 अश्मा नवमोऽग्नीधे ।

13 26 होत्रीयमतः संवक्ष्यामो । अंसश्रोण्योः पद्याश्रया नकुलका बहिस्तिसृषु दिक्ष्वन्तश्चतुर्दश पदकचतुर्थाः स यः प्रतिदिशमष्टौ पद्या दिक्षु विदिक्षु ।

13 27 ब्राह्मणाच्छंस्ये दश चैका स्युर्मध्ये द्वौ द्वौ चतुर्थ्यौ नकुलश्च ।

13 28 अभितस्तिस्रण् पद्या द्वे मध्येऽध्यर्धे शिष्टेष्वष्टौ ।

13 29 अध्यर्धाः षण्मार्जालीयेऽस्त मार्जालीय स्याद्दक्षिणपार्श्वेन शामित्र चात्वालस्य च पश्चादवभृथ कल्पेऽप्येवं पदमेकतस्त्रिपदस्तिस्रोऽतिरिक्तेष्विति ।

14

14 1 सप्तत्रिंशत्सार्धः पक्षः सव्यश्च शिरसि चत्वारः षड्विंशकस्तथात्मा श्येने पञ्चदशक पुच्छम् । सप्तदशक पुच्छ द्वयं शिरस्यात्मपक्षयोः क्लृप्तमलजस्य । भागसन्धान्तयज्ञैः प्रमितान् नरचतुर्थे । (10 3 5)

14 2 अष्टौ भागाः पुच्छं कङ्कचिते भवन्ति पादयोश्चतुरः शिरसि तु सप्त ज्ञेयाः श्येनवदात्मा च पक्षौ च ।

14 3 श्येनालजकङ्कामष्टौ सार्धा विस्तृतं पुच्छ चत्वारोत्मा द्वौ च शिरः सर्वेषां पञ्चकौ पक्षौ ।

14 4 श्येनालजकङ्कानां द्वित्रिचतुः कुष्ठमित्युच्यते पुच्छम् । पञ्चाक्ष्णाः पक्षपात्रास्त्वक्ष्णाभिः परिश्रिताः ।

14 5 पुच्छे द्वौ भागावानयत्पुच्छमलजेन त्रिकुष्ठवत्त्रीन्श्येनपुच्छाच्छिरसि कङ्के पादौ तु हरेत् ।

14 6 प्राचीर्द्वादश सार्धा विंशतिरुदीचीर्भवेन्मिता भागा । दश पञ्च कङ्कचितावलज उदीचीस्रयोदश सार्धाश्च ।

14 7 त्रिचतुर्भागमानी स्याद्रज्जुरर्धत्रयोदशी ।
मध्ये च लक्षणं तस्याश्चतुर्भागैर्निराञ्छनम् ॥

Indological Truths

14 8a भागिकाश्चत्वारस्तोदा अर्धषष्ठेऽपरः स्मृतः ।
अर्दाश्च मेऽष्टमे चैव नवमे दशमेऽपरः ॥

14 8b अर्धद्वादशो वान्यः ।

14 9 ततः प्राचीः प्रसार्य तु तस्या निखानेच्छङ्कुम् । पाशयोर्मध्यमेऽष्टमे । चतुर्थे वाहत्य पाशम् । आसज्य मध्यमे निराल्छनम् ।

14 10 निरायम्य विनुद्योन्मुच्य मध्यमात् । अभितो दशम आयम्य भागाद्विकचतुष्काः । अर्धषष्ठेऽपि चाहत्य पूर्वादेवं समाचरेत् । तुल्य शङ्कु तुर्ये ।

14 11 ततः प्राचीः प्रसार्य तु अर्धषष्ठकयोः पाशौ । शङ्कू अर्धाष्टमेऽष्टमे । प्रगृह्य पश्चिमशङ्कू । द्विकयोर्वोत्सृजेत्ततः ।

14 12 चतुर्थनवमौ शङ्कू प्रवृहेदन्तिमावुभौ ।

14 13 अष्टमे पाशमासृज्य अष्टमेनैव निग्रहः । भागेभागे ततः शङ्कू तयोः ।

14 14 अष्टमे पाशमासृज्य आदशङ्कौ निगृह्य च ।
दशमे शङ्कुमाहन्यात्पुच्छार्धे अलजस्य तु ॥

14 15 स्यार्धाष्टमे शङ्कुः कङ्कस्य दर्शने स्मृतः ।

14 16 त्रिके पाशं समासृज्य दशकेन निगृह्य च ।
एताभ्यामेव तोदाभ्यां शङ्कू देयौ तथोत्तरौ ॥

14 17 अर्धद्वादशमे पाशस्त्रिको निग्रहणो भवेत् ।
आदिपाशे द्विके चैव शङ्कू देयौ तथोत्तरौ ॥

14 18 उत्तरे द्विकमासज्य दक्षिणं समयोर्हरेत् ॥

14 19 चतुर्थे शङ्कुमाहन्याद्विपरीतं समाचरेत् ।
वतुर्थे तु तदर्धेन निर्गृह्य च . ॥

14 20 इति श्येनस्य रज्जर्द्वादशलक्षणा ।

14 21 चत्वारि करणान्येषां त्रिचतुर्थेन कारयेत् ।
नवभागा अक्ष्णार्धाक्ष्णाः पञ्चकोणाः च भागशः ॥

14 22 प्राचीने पञ्चकोणे द्वे अथार्धाक्ष्णाद्वय न्यसेत् ।
अंसाग्रयोरथैकैका एवं पक्षविपक्षयोः ॥

Indological Truths

14 23 नवभागैश्चितं मध्यमक्ष्णाभिः परिषिञ्चते ।
पक्षाग्रे पञ्च पत्राण्येवं चाक्ष्णा विधीयते ॥

14 24 व्यत्यासाक्ष्णाद्वयं तुन्दे पञ्चकोणे प्रत्यक्स्थिते ।
अर्धाक्ष्णे कण्ठसन्ध्योश्च पूरयेदमितं शिरः ॥

14 25 द्वे पक्षसन्ध्यौरर्धाक्ष्ने पुच्छसन्ध्योस्तथापरे ।
दश पञ्च च पुच्छाग्रे पक्षाग्र एकविंशतिम् ॥

14 26 औपमाने चयने चैषा व्यत्यासे करणेषु च ।
रज्ज्वाश्चावपनं ह्रासो श्येनसिद्धिरिति स्थितिः ॥

14 27 अवक्रपक्षमलजं च पूर्वपक्षे तथायुतम् ।
मध्यात् प्रसिद्धं पुच्छं श्येने दाम्ना प्रसिद्ध्यत इति ॥

14 28 नवमात्राग्भागे शङ्कू तुरीयस्य करणम् ।
अलजे पक्षार्धमवक्रताद्ध्येवं भवेत् ॥

15

15 1 पुरुषस्य तृतीयपञ्चमौ भागौ तत्करणं पुनश्चितेः । (10 3 6)
तस्यार्धमथापर भवेत्तृचितिकमग्निचितिश्चेत् ॥

15 2 अष्टावष्टौरम्मिता चितिरष्टैकादशिका च मध्यमा ।
व्यत्यासवतीरुपन्यसेदष्टौ द्वादश चोत्तमा चितिः ॥

15 3 पञ्चदशनर क्षेत्रं प्रौगोचित्ततस्त्वर्धम् ।
मध्याद्दशके त्रिकुष्ठमेतत्तथा करणम् ॥

15 4 बाह्वोरेकविंश उभकरणे तथार्धोऽन्यश्च ।
असश्रोण्योश्छेदस तस्योभयतो भवेत् प्रौगः ॥

15 5 चात्वालेभ्यश्चतुर्भ्यस्तु समूह्योऽग्निरनिष्टकः ।
दिग्भ्यः पुरीषैः समूह्यो भागशो युक्तितो विधिः ॥

15 6 मण्डलचतुरश्रोऽद्ये परिवार्यः श्मशानचित् ।
द्रोणचित्त्सरुमानेषां दशभागो भवेत्सरुः ॥

Indological Truths

15 7 मण्डले चतुरश्र तु कुर्याद्गार्हपत्यावत् ।
बाह्वोर्विंशतिभागेन वारुण सार्धमेव तु ॥

15 8 प्रसिद्ध दशधा कुर्याद्वहिरन्तश्च युक्तितः ।
त्रिकुष्ठश्च विषाणः स्यात्सन्धौ व्यत्यास एव सः ॥

15 9 चतुरश्रस्य करणं बाह्वोर्द्वात्रिंशद्भागिकम् ।
चतुरश्रमथाध्यर्धं ताभ्यां गायत्रवद्विधिः ॥

15 10 साहस्रस्य करण बाह्वोः पञ्चदशभाग चतुरश्रम् ।
अध्यर्धास्तु ततः स्युर्द्विंशताश्चितयः स्मृताः ॥

15 11 पञ्च पञ्चाशतमध्यर्धास्तिस्रः पञ्चाशतं चतुरश्रः ।
सहस्राच्छत पक्षाः स्युरुषा सहस्रतमी ॥

15 12 बाह्वोरेकत्रिंशो भागः करण चितिस्तथोत्तरयोः ।
चतुरश्रानां साहस्रं सवनिके व्यवास्यन्ति ॥

15 13 अर्धैकादशपुरुस घन भवेद्भवेनमण्डलं रथचक्रम् । नाभिररा विवरधा नेमिररेभ्यो यद्यतिरिक्तम् ।

15 14 तदर्धाः पुरुषायामाः पुरुषाष्टभागविस्तृताः चतुर्विंशतिस्त्रिनरनायाः ।

15 15 विवरकरणमतः सम्प्रवक्ष्यामि । द्विसप्तमेन नेम्यस्रकरणं भवेदरस्याष्टभागेन वीकृतश्चतुर्विंशतिभागेन नाभ्यामन्तरमन्तरोऽष्टमभागेन प्रौगवोद्भवेत् ।

15 16 द्वीष्टकां चिनुयान्नाभिं चतुर्भिश्चिनुयादरान् ।
त्रिभिर्नेमिं यथाभागं व्यत्यासः कूपवत् स्मृतः ॥

15 17 विष्कम्भस्य चतुर्थेन नाभ्यास्तु विवरं लिखेत् ।
त्रिचत्वारिंशाङ्गुलां नेमिं सार्धचतुरङ्गुलाम् ॥

15 18 सिद्धमन्यद्यथा युक्तिश्चयने याश्च सम्पदः ।

15 19 य इदमपि यथातथं स्मृतिं विधिं यदाधित्य मिमीते रौरवं समवति खलु कृत्स्नसम्मतो व्रजति च शुल्बकृतां सलोकताम् ॥

16

16 1a रथचक्रस्य चित्यस्य सङ्क्षेपोक्तस्य विष्णुना । (10 3 7)
अथ धातुर्निर्विष्टस्य त्रिगुणान्य बहिर्बहिः ॥

Indological Truths

16 1b लीयन्ते मण्डले यस्य सप्त सार्धा नरा बुधैः ।

16 2 मुच्यन्ते विवरेष्वन्ये क्षेत्रादभ्यधिकास्त्रयः ।

16 3 तस्य चक्रविधानं तु नेमिररेभ्यो विस्तरः ।
मण्डलानां च विष्कम्भः त्रिभागः करणानि च ॥

16 4a नरार्धेनाभिलिखेन्नाभिस्ततः प्रस्तारगोचरा ।
अरेभ्योऽभ्यधिका नेमिस्त्रिषष्ठेनाक्षरागारम् ॥

16 4b त्रिंशतेन सर्विंशेन अधिकैश्चार्धपञ्चमैः ।
मिमायाङ्गुलैर्वा मध्यं कुर्याद्विंशेन परिलेखनम् ॥

16 5 प्रथमे प्रस्तारे रथचक्रस्य शृणुतेष्टकाः ।
चतुर्भिरधिक वेत्थ चत्वारिंशच्छतत्रयम् ॥

16 6 द्वितीयेऽभ्यधिका यान्तु चतुर्विंशतिरिष्टकाः ।
पञ्चकोणास्त्रिकोणाश्च नेम्यरेभ्यः च सन्धिषु ॥

16 7 इष्टकानां सहस्रेण शतैः सप्तभिरेव च ।
अष्टषष्ट्या च चक्रस्य चितयः पञ्च पूरिताः ॥

16 8 इति शुल्बसूत्रं समाप्तम् ॥

* * *

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51 ಋಗ್ವೇದ ಸಂಹಿತಾ (೩೭ ಸಂಪುಟಗಳಲ್ಲಿ) ಸಂ ಎಚ್ ವಿ ವೆಂಕಟರಾವ್, ಶ್ರೀ ಜಯಚಾಮರಾಜೇಂದ್ರ ವೇದರತ್ನ ಗ್ರಂಥಮಾಲಾ, ಮೈಸೂರು

52 ಕನ್ನಡ ಮಹಾಭಾರತಗಳಲ್ಲಿ ಶಿಲ್ಪ ಮತ್ತು ಶಿಲ್ಪಿ ಡಾ। ಜಿ ಜ್ಞಾನಾನಂದ, ಸಂಸ್ಕೃತಿ ಸಾಹಿತ್ಯ ಪ್ರತಿಷ್ಠಾನ

53 ಕಾತ್ಯಾಯನ ಶ್ರೌತಸೂತ್ರಂ (ಮಹೀಧರವೃತ್ತಿಸಹಿತ) : ತೆಲುಗು–ಸಂಸ್ಕೃತ ಪ್ರತಿ

54 ಕೃಷ್ಣಯಜುರ್ವೇದ ತೈತ್ತಿರೀಯ ಸಂಹಿತೆ (ಸಾಯಣ ಭಾಷ್ಯದೊಂದಿಗೆ) ಆನಂದಾಶ್ರಮ, ಪುಣೆ

55 ದಶೋಪನಿಷತ್ ಶ್ರೀ ರಾಮಕೃಷ್ಣಾಶ್ರಮ, ಬೆಂಗಳೂರು

56 ಭಾರತೀಯ ಗಣಿತಶಾಸ್ತ್ರದ ಹಾಗೂ ತಂತ್ರಜ್ಞರ ಚರಿತ್ರೆ ವೇಣುಗೋಪಾಲ ಹೇರೂರು, ರಾಷ್ಟ್ರೋತ್ಥಾನ ಸಾಹಿತ್ಯ, ಬೆಂಗಳೂರು

57 ಭಾರತೀಯ ವಿಚಾರಧಾರೆ ಶ್ರೀ ಕುಳಮರ್ವ ವೆಂಕಪ್ಪ ಭಟ್ಟ, ಕೈಂತಜೆ ಪ್ರಕಾಶನ, ಉಪ್ಪಿನಂಗಡಿ

58 ಭಾರತೀಯ ವಿಜ್ಞಾನದ ಹಾದಿ ಡಾ। ಜಿ ರಾಮಕೃಷ್ಣ, ಪ್ರಸಾರಾಂಗ, ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಹಂಪಿ

59 ಭಾರತೀಯ ವಿಜ್ಞಾನೋಪಾಸನೆ ಪದ್ಮನಾಭ ಪುರಾಣಿಕ, ಕರ್ನಾಟಕ ಸಾಹಿತ್ಯ ಮಂದಿರ, ಹೈದರಾಬಾದು, 1947

60 ಸಂಸ್ಕಾರ ಸಂಜೀವಿನಿ ಮೀಮಾಂಸಾ ವಿದ್ವಾನ್ ಶ್ರೀ ವಾಸುದೇವ ಪರಾಂಜಪೆ

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Courtesy :

Some of the diagrams and figures which I incorporated in this thesis are copied from the following books-

1 **Layout and Construction of Cities according to Baudhāyana, Mānava and Āpastamba Śulbasūtras** by Dr R P Kulakarni

2 **The Layout for different sacrifices according to different Śrautasūtras,** by Dr R P Kulakarni,

3 **The Śulbasūtra of Baudhāyana, Āpastamba, Kātyāyana and Mānava** with English Translation and Commentaries by S N Sen and A K Bag

4 **Principles of Yajña-vidhi** (Introduction) by Prof S K Ramachandra Rao

5 ಕನ್ನಡ ಮಹಾಭಾರತಗಳಲ್ಲಿ ಶಿಲ್ಪ ಮತ್ತು ಶಿಲ್ಪಿ ಡಾ। ಜಿ ಜ್ಞಾನಾನಂದ,

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